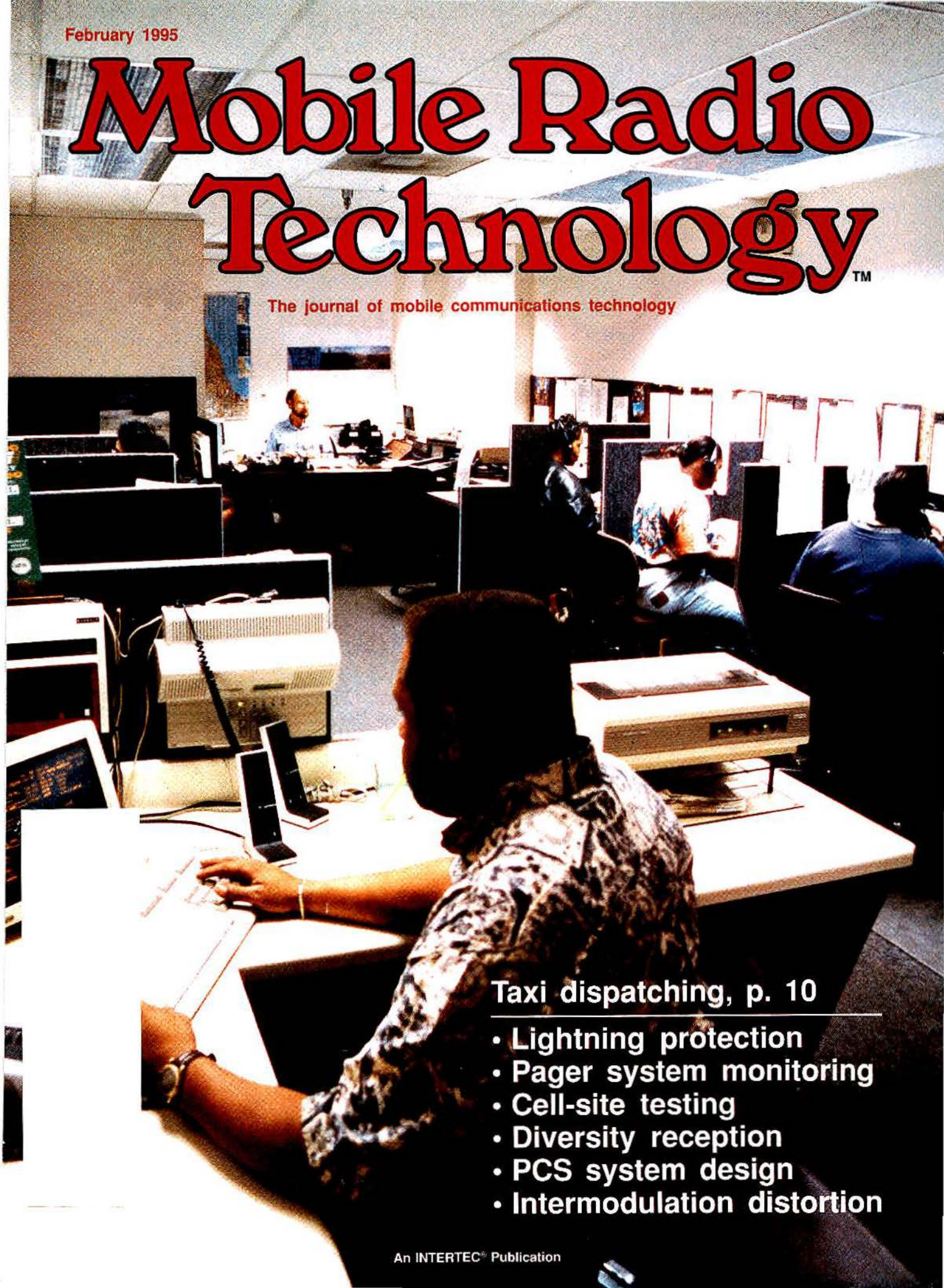
February 1995

# Mobile Radio Technology™

The journal of mobile communications technology

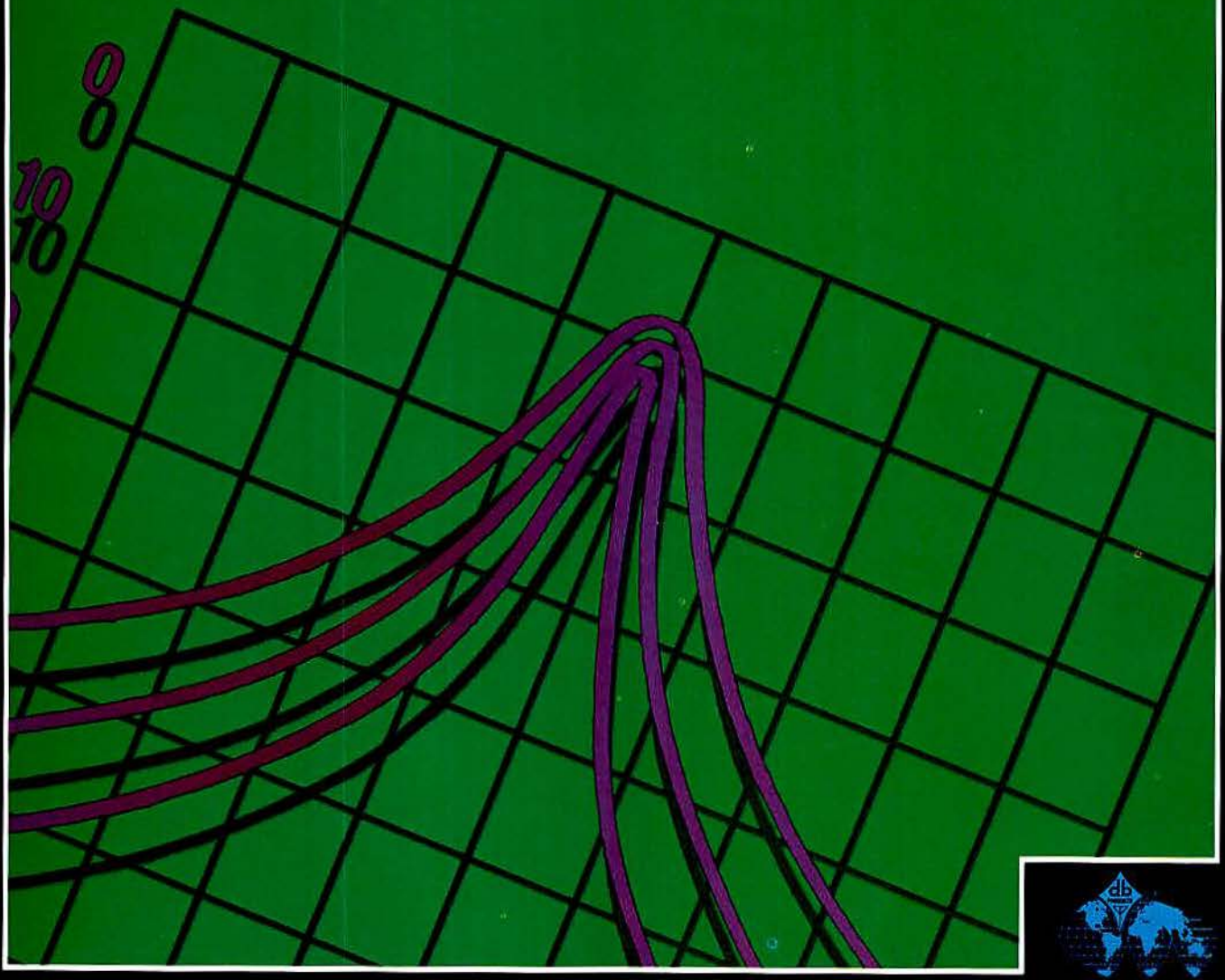


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- Lightning protection
- Pager system monitoring
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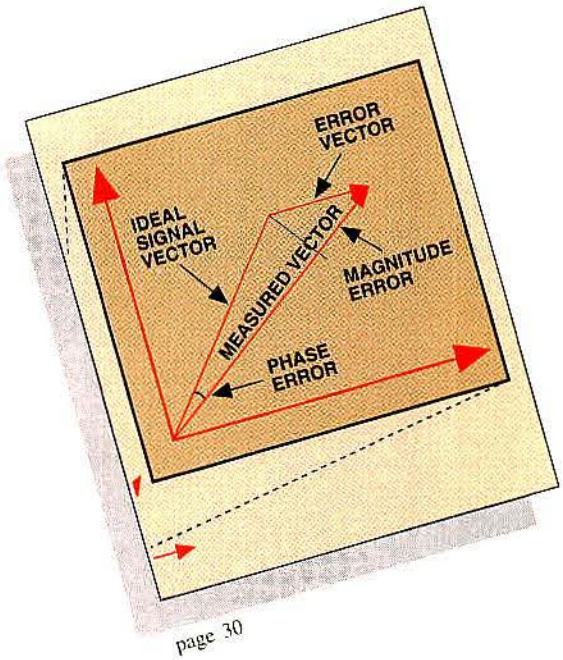
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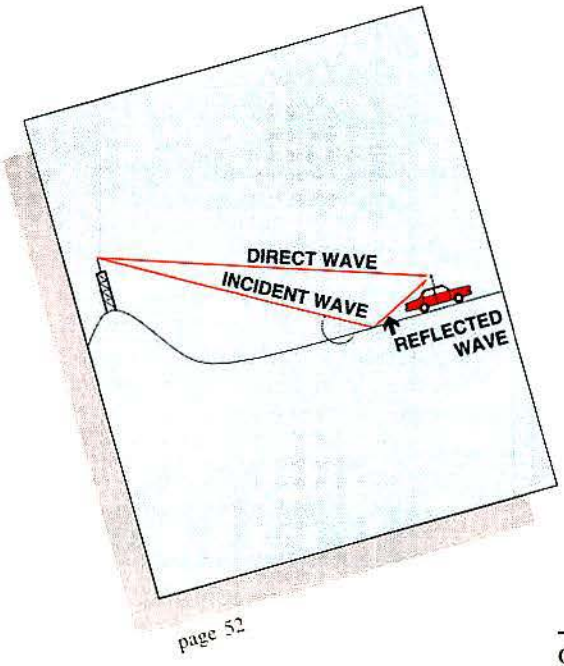
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**On the cover:** A taxi dispatch supervisor in Chicago uses the Cabmate dispatch system from Gandalf Mobile Systems, Overland Park, KS. Calltakers are in the background. *Photo by Janusz Gryglak.*

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SUBSCRIPTIONS: Non-qualified persons may subscribe at the following rates: United States and Canada: one-year: $30.00. Qualified and non-qualified persons in all other countries; one-year: $40.00 (surface mail); $105.00 (air mail). Subscription information: P.O. Box 12937, Overland Park, KS, 66282-2937.

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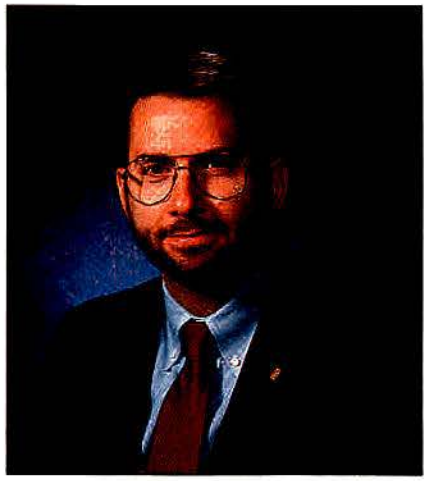
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# Kay to get his hearing; more licensing irregularities?



Our December 1994 editorial described a $2.9 million lawsuit filed against three FCC employees in connection with the possible violation of a Los Angeles radio system operator's civil rights. In the 10-count complaint, James A. Kay Jr. asserts that he is entitled to due process of law before agents of the United States may deprive him of life, liberty or property; to protection from unreasonable search and seizure; to protection from unlawful *in rem* forfeiture of property; and to protection of his right of privacy.

Among other things, Kay has been asserting his right to a hearing before decisions are made to dismiss or delay his license applications, revoke existing licenses or set aside any renewals of his private land mobile radio licenses.

Not long after the lawsuit was filed and the editorial was published, the FCC decided to give Kay a hearing. Specifically, the commission has ordered Kay to show cause why his licenses should not be revoked or canceled; why he should not be ordered to cease and desist from certain alleged violations of the Communications Act and the commission's rules; and why he should not be ordered to pay a fine. The FCC further ordered itself (yes, that is the way the order reads) to bear the burden of introducing evidence and proving its case. To a great extent, this is what Kay has been demanding all along.

What the FCC left out of its list of issues to be covered by the hearing are some of Kay's complaints about actions that were taken prior to the order-to-show-cause that apparently have deprived him of due process. The scope of the hearing should be expanded to shed light on the handling of Kay's license applications and renewals. In addition, it is important to establish the limits of the commission's authority to search private records.

**More licensing irregularities?**

An analysis of FCC license grants during the last week in July and the first week in August 1994 shows an unusual pattern of specialized mobile radio (SMR) license application processing at the FCC. The analysis is contained in comments filed with the commission in connection with a proposed merger between Rutherford, NJ-based Nextel Communications and Denver-based OneComm. OneComm received license grants for *thousands* of frequencies in several western states during this period. On some days, apparently only OneComm's applications were processed, to the exclusion of any other applicants.

The period is significant because on Tuesday, Aug. 9, the FCC imposed a moratorium (a "freeze") on accepting new applications for SMR licenses. Certain provisions of legislation pertaining to spectrum auctions became effective on Aug. 8, apparently leading the FCC to seek ways of abandoning the established SMR licensing process in case a way could be found at some future time to auction SMR frequencies—whether or not such abandonment conformed with existing rules or federal law.

The possibility of the freeze was widely known in the corporate and legal communities during July, and many companies rushed to file applications, not knowing exactly when the freeze would be announced. You see, not only was the possibility of the freeze an open secret, so too was the likelihood that the FCC would *stop granting licenses* as of the date of the freeze—with the possibility that pending applications would be *dismissed* and the remaining frequencies auctioned.

Thus, it was not only important to have one's applications filed before the freeze, but only applications that resulted in *license grants* before the freeze would be protected from actions the FCC might take *after* the freeze. Having thousands of frequencies licensed and on the books before the freeze would make a nice "insurance policy" at an average value of, say, $20,000 per channel.

Despite the FCC's public complaints that it lacked sufficient resources to process its license application backlog, and despite its record of handling only 100 or 200 SMR applications per week before this remarkable two-week period, somehow the agency found the capability of granting 1,200 channels on Aug. 2 and 1,300 channels on Aug. 3 in Colorado to a single applicant—OneComm. Thousands more channels were licensed to OneComm in Washington state, Oregon and Oklahoma on Aug. 4 and 5—and 2,400 more in Washington state on *Saturday*, Aug. 6!

On July 14, about a week before the intensive processing of OneComm applications began at the FCC Licensing Division, Nextel announced a merger agreement with OneComm, raising the possibility of a connection between Nextel's influence at the FCC and license grants to OneComm.

The processing of OneComm applications representing thousands of channels during the two weeks before the freeze and following the Nextel merger announcement raises some of the same issues as the James Kay case. For example, Kay has complained that the FCC delayed acting on many of his applications while processing other applications submitted *after* his. During this flurry of OneComm application processing, how many applications filed by small SMR operators ahead of OneComm were skipped over, when the rules require applications to be processed in the order received?

Why did the FCC say in 1994 that it was unable to process its backlog of SMR applications? (Later, the FCC accepted a $20,000 donation from a coalition of trade associations to help with its processing.) Its record of issuing licenses from July 23 to Aug. 8, 1994, demonstrates an ability to grant a thousand or more channels in a *single day*.

This is not to say that the applications were processed *well*. Among the channels granted are examples of short-spacing (licenses for locations closer together than the rules allow). For example, Washington state has 19 sites that require 105-mile spacing between stations on those sites and stations on the same frequency at other sites. In other regions, 70 miles is the separation requirement. The 105-mile rule for the Washington state sites seems to have been overlooked. In the most ridiculous instance, a channel was granted for a site only *100 feet* from an existing licensed co-channel site. Multiple instances of short-spacing indicate that the applications may not have received even a *minimal* review before being granted. It is faster to process thousands of channels with a rubber stamp than with a geographic separation analysis.

Why did the FCC give OneComm such favorable treatment in comparison to small SMR operators with pending applications?

*—Don Bishop*

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# Calendar

## February

**1-3—Cellular Telecommunications Industry Association Winter Meeting and Exposition,** New Orleans. Contact: 202-785-0081.

**20-23—Inter Comm,** Canada's Global Telecommunications Congress and Exhibition, Vancouver, British Columbia, Canada. Contact: Will Fong, 604-669-1090.

## March

**13-14—AMTEX,** the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, The Buttes, Tempe, AZ. Contact: 202-331-7773.

**16-17—Government Land Mobile Communications Conference,** sponsored by TMSA Conferences, Rosslyn Westpark Hotel, Arlington, VA. Contact: Steven Silver, 310-534-4871.

**20-23—Supercomm,** sponsored by USTA and TIA, Anaheim Convention Center, Anaheim, CA. Contact: 202-326-7300.

## April

**3-5—Energy Telecommunications and Electrical Association,** George R. Brown Convention Center, Houston. Contact: 214-235-0655.

**12-13—Wireless Business Telephone Systems,** sponsored by Alexander Resources, Bristol Suites Hotel, Dallas. Contact: Carole Kaufman, 800-948-8225.

**25-27—International Wireless Communications Expo/Spring,** Las Vegas Sands Convention Center, Las Vegas. Contact: 800-828-0420.

## May

**17-19—Mobile Communications Conference,** sponsored by the Personal Communications Industry Association (PCIA), Hotel del Coronado, San Diego. Contact: Nancy Palleschi, 800-759-0300.

**31-June 2—Radiocomm,** Toronto Metropolitan Convention Center, Toronto. Contact: 613-233-4888.

## July

**26-28—Vehicular Technology Conference,** sponsored by IEEE Vehicular Technology Society, Hyatt Regency Chicago O'Hare, Chicago. Contact: Keith Paglusch, chairman, 312-399-2378.

**31-Aug. 4—Utilities Telecommunications Council,** Hyatt Regency and Convention Center, Minneapolis. Contact: 202-872-0030.

## August

**13-18—Association of Public-Safety Communications Officials—International National Conference,** Detroit. Contact: 800-949-2726.

## September

**20-23—Personal Communications Showcase,** sponsored by the Personal Communications Industry Association (PCIA), Orange County Convention Center, Orlando, FL. Contact: 800-326-8638.

## October

**18-20—International Wireless Communications Expo/Fall,** Tampa Convention Center, Tampa, FL. Contact: 800-828-0420.

**26—ERA Communications Trade Fair,** Ala Moana Hotel, Honolulu. Contact: 310-287-1218.

## November

**7-9—WirelessWorld Conference and Exposition,** sponsored by *Cellular Business* and *Mobile Radio Technology* magazines, Moscone Convention Center, San Francisco. Contact: Chris Lotesto, 800-458-0479.

**8-12—Communications Marketing Conference,** sponsored by the Communications Marketing Association, Albuquerque, NM. Contact: Bernie Brownson, 303-371-8182.

**17—Radio Club of America,** Communications Symposium, 86th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Ron Formella, 201-652-6811.


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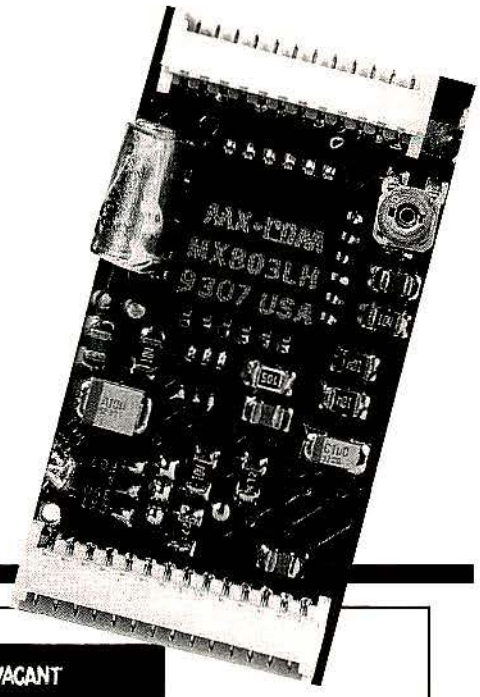
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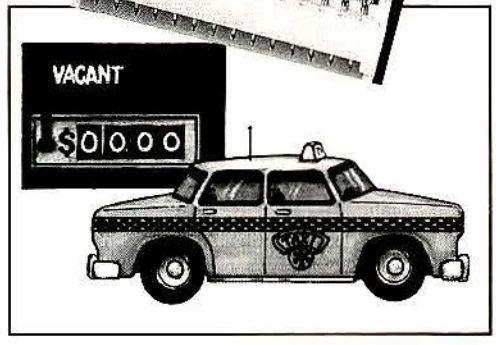
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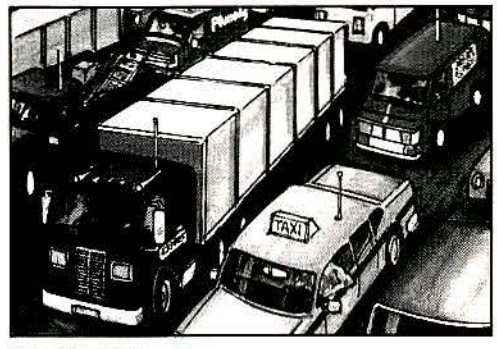

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# Modulation density

By Harold Kinley, C.E.T.

The late William Detwiler, founder of Helper Instruments, Indialantic, FL, probably is best known for making the SINAD meter so easy to use that it has become indispensable to the radio communications technician. However, that is not Bill's only accomplishment! Though it never caught on like the Sinadder meter, Bill's *modulation density* meter was a major leap forward.

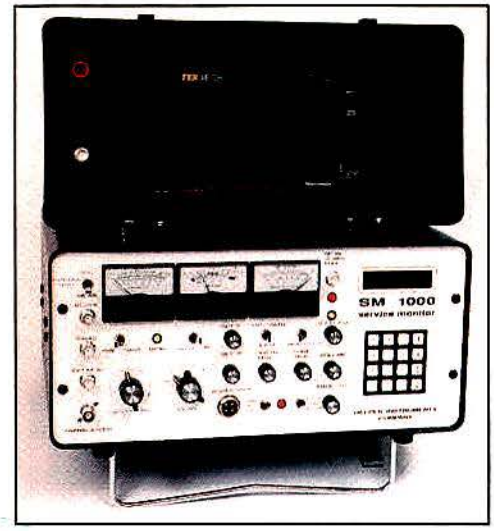



Photo 1. The instrument used to measure modulation density is available as a standard feature of the Helper Instruments model SM-1000 service monitor.

### What is modulation density?

Modulation density is a measure of the *average* degree of modulation caused by a *speech* signal, whether AM or FM. Although a tone signal or a loud, sustained whistle (through the microphone) can be used to set an FM transmitter's *instantaneous peak deviation level*, modulation produced by actual *speech* signals may be quite different from what you expect.

For example, even though a constant tone may be used to set the peak deviation level of an FM transmitter, it does not automatically follow that the transmitter will produce good *average* modulation with a speech signal. Insufficient gain ahead of the clipper would cause poor average modulation with typical speech signals. Because raw speech signals cover a wide dynamic range, compression and clipper circuits typically are used to boost the speech signal's average modulation level. Remote control consoles boost the average speech level by using a compression amplifier. An FM transmitter's audio stages use clipper circuits that clip the peaks to prevent the transmitter from exceeding its peak deviation level. Audio controls in a typical arrangement are shown in Figure 1 below right for a remotely controlled system. Just look at the number of audio controls that must be adjusted for proper modulation.

Without the use of a proper modulation density measuring instrument, the setting of audio levels for the best speech modulation is purely subjective, and the levels selected vary from technician to technician. For example, many service monitors have a peak deviation alarm that can be set to indicate when modulation peaks hit a selected level. Typically, when checking for proper modulation levels, I use the following procedure:

(1) Set the peak deviation to +5kHz using a constant-tone signal.

(2) Set the deviation alarm to +5kHz. Speak normally into the microphone, and make sure that the peak deviation does not exceed the +5kHz level on voice peaks.

(3) Set the deviation alarm to +4.5kHz, and monitor the alarm while speaking normally into the microphone. If the alarm activates on almost every syllable, then the average modulation is too high (too much gain ahead of the clipper). If the deviation alarm sounds frequently (not on every syllable), then the average modulation is about right. If the deviation alarm sounds only on occasional speech peaks, then the average modulation is too low. So, we have "high average," "low average" and "medium average" modulation levels to choose from. The proper choice is "medium average!"

After having used an analog deviation meter for quite some time, a technician may be able to recognize when the average modulation is set correctly by observing where the "average" peaks of the meter needle hit with typical speech modulation signals. Another technician may have a *different* idea of what may be the *proper* "average" modulation using the same equipment. It becomes a matter of individual judgment. Not very scientific, is it?

### Modulation density defined

Bill Detwiler defined modulation density in the following manner. First, a 1,000Hz tone well above the clipping threshold is used to modulate the transmitter, and the peak deviation control is set to +5kHz. Then the 1,000Hz tone signal is reduced in amplitude until the peak deviation is +3kHz. At this point, an average-voltage-detecting indicator is substituted for the peak-reading modulation meter. This voltage reading then is taken to indicate 10 *modulation density* units.

*"To determine the modulation density of the transmitter under actual operating conditions, the 1,000Hz test signal is removed, and the normal transmitter speech source is connected to the transmitter input. The average-voltage-detecting indicator is observed through several words of the speech source, and the highest indication is noted. The modulation density of the transmission is then calculated as:"*[1]

$DU$ = (Maximum average voltage with speech signal + Average voltage with 3kHz peak deviation on sine wave) × 10

The modulation density meter's meter-

1. William Detwiler, "What the Modulation Monitor Has Missed," *Communications* reprint.

*(continued on page 59)*

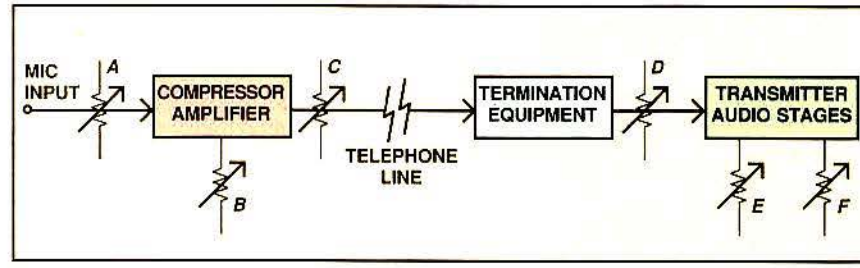
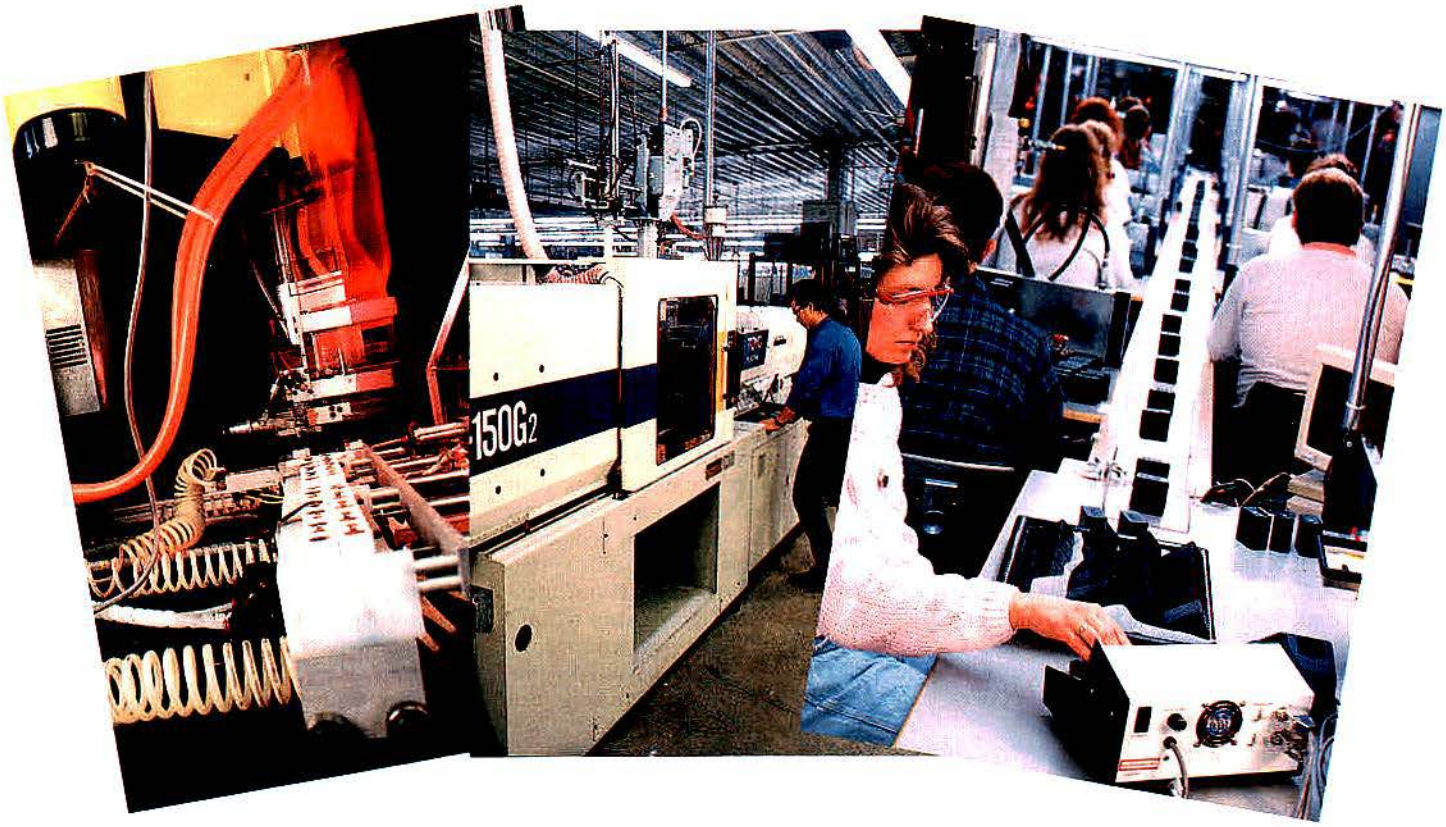



Figure 1. A typical remote control system has muliple audio controls that must be adjusted for proper transmitter modulation.

Kinley, a certified electronics technician, is regional communications manager, South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985. He is a member of the Radio Club of America.

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# Computer tracks taxi locations, improves dispatching results

*Taxis are located automatically within zones for speedier customer response. Computerization integrates taxi company order entry, dispatch, management and communications operations.*

**By R.L. Paschall**

Computerized dispatching resolves inherent problems with manual voice dispatching systems, increases business volume and profits, and improves overall company management — regardless of fleet size.

Basic systems automate order entry and enhance voice dispatching. Advanced systems automate fare-matching and dispatching. Both systems offer the option of two-way mobile data communications.

### Dispatch system history

Five distinct generations span several decades of dispatch system evolution.

The first generation is marked by the proliferation of call-box telephones. Taxis would gather in a physical zone (rank) wherever there was a call box. After receiving fare information over the telephone, drivers proceeded to the customer's location. After completing the fare, drivers returned to the call box for the next fare.

In the 1930s and 1940s, a second-generation dispatch system used electron-tube mobile radios that allowed taxis to rove across citywide zones while maintaining communication with a dispatcher. Although these early radio systems were somewhat crude, they introduced the public to new levels of service and convenience.

During the 1950s and 1960s, the transistor and other solid-state devices dramatically changed radio communications. Representing a third generation of dispatching with better technical performance, these radios were more reliable and cost much less than their predecessors.

Fourth-generation dispatch systems came in the 1970s in the form of computerized dispatching. These systems used a minicomputer in the dispatch office and small mobile computer terminals in each vehicle. Existing radio equipment provided the mobile data communications path. These systems allowed drivers to exchange information with the dispatch computer.

The fifth-generation dispatch system uses computers, operating systems, application software and mobile data technology to further improve performance, reduce costs and increase reliability by integrating order entry, dispatch, management and communications operations.

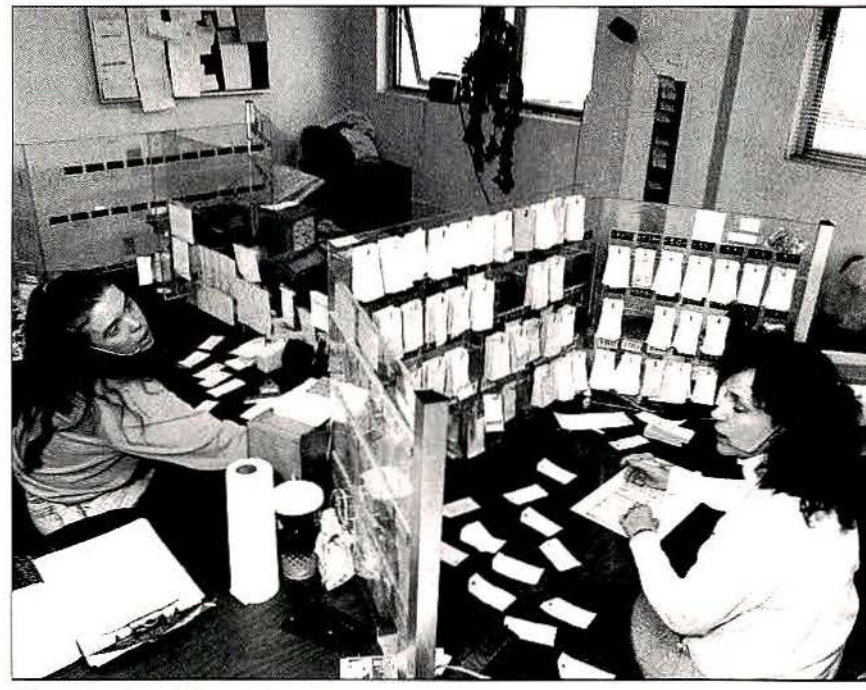
### Functions

The computerized dispatch system's main functions include:

- organizing the service area.
- automating the fare entry process.
- managing the taxi company's operation.
- controlling the taxi company's operation.
- dispatching fares.
- communicating with the vehicles.

### Organizing the service area

Before the system is installed, the taxi company's service area is evaluated to determine the most efficient way to subdivide it into several smaller zones. Zone size depends on the amount of business in certain areas; natural boundaries such as streets, rivers, parks and railways; and municipal boundaries.



**Prior to the installation of the computerized dispatch system, Kathy Beverage (left) and Linda Dyson used a pegboard assignment system and voice radio to dispatch Yellow Cab and Capitol Cab taxi drivers to their fares. *Courtesy of* The Des Moines Register. *Photo by Bill Neibergall.***

Paschall is director of sales and marketing at Gandalf Mobile Systems, Overland Park, KS.

It should take no more than 10 minutes for a vehicle to travel from one side of a zone to the other. This guideline keeps the time short between receiving the fare request, dispatching the fare and delivering a taxi to the customer's location.

Street names, address numbers and building names are entered according to their zone for permanent storage as a computerized street directory database. The system uses the zones and street directory to determine the exact location of a customer and to track which vehicles are available to serve the customer.

The system tracks vehicles and fares zone by zone. A separate list (queue) of fares and vehicles is maintained for each zone. When the system receives a customer fare request, it compares the customer's address to the computerized street directory and determines in which zone the fare is located. The system then places the fare in a queue along with other fares waiting for a vehicle within that particular zone.

When drivers report for work, they indicate which zone they are in. The system places the vehicle into a queue with other vehicles waiting for a fare within that zone. The system then matches fares in a zone with vehicles in the same zone. The result is customer service in the shortest possible time.

**Automating fare entry**

In most taxi companies, customer requests (fares) are recorded manually. Calltakers write each fare on a call slip. The calltaker passes the call slip to a dispatcher who organizes the fares and calls them out to the vehicles.

Manual fare recording systems are highly inefficient. They are prone to errors and misplaced information, and they are wide open to favoritism. If a calltaker writes down the wrong information, or if a call slip is misplaced, the customer may never get service.

*Automated fare entry eliminates the paper trail and aids calltakers in performing their duties.*

Automated fare entry eliminates the paper trail and aids calltakers in performing their duties. Each calltaker is equipped with a video display terminal connected to the computer. The terminal displays fill-in-the-blank forms similar to the one shown in Figure 1 on page 14. This form prompts the calltaker to enter as much information as possible and ensures that the details are consistent and accurate. The computer sorts, records and stores the fare.

There are a number of ways to sort fares. For example, the computer can sort them according to *originating zone, priority* or an *oldest-to-newest* basis. The method used depends on the way the taxi company operates.

Computer records improve management by keeping track of all fares, billing account customers, generating the system and operator activity reports, and identifying problems.

**Managing the operation**

The system can provide detailed reports to help with managing the taxi company. Specific reports are selected from a list on a display screen, similar to the one shown in Figure 2 on page 14. Each report provides a detailed accounting of a particular part of the operation. These reports can be used to identify and analyze areas that are working well and those that need improvement.

System activity reports allow the manager to analyze fare distribution, to examine fare dispatching, to bill account customers, to review operator activity, to investigate suspensions and to survey driver usage.

If the company has account customers, the system maintains records of each fare charged to their account. This information then can be used to bill the customer.

In some cases, the system can automatically transfer its account records to an existing accounting system. This eliminates double-entry of account information, saves time and reduces the chance of billing errors.

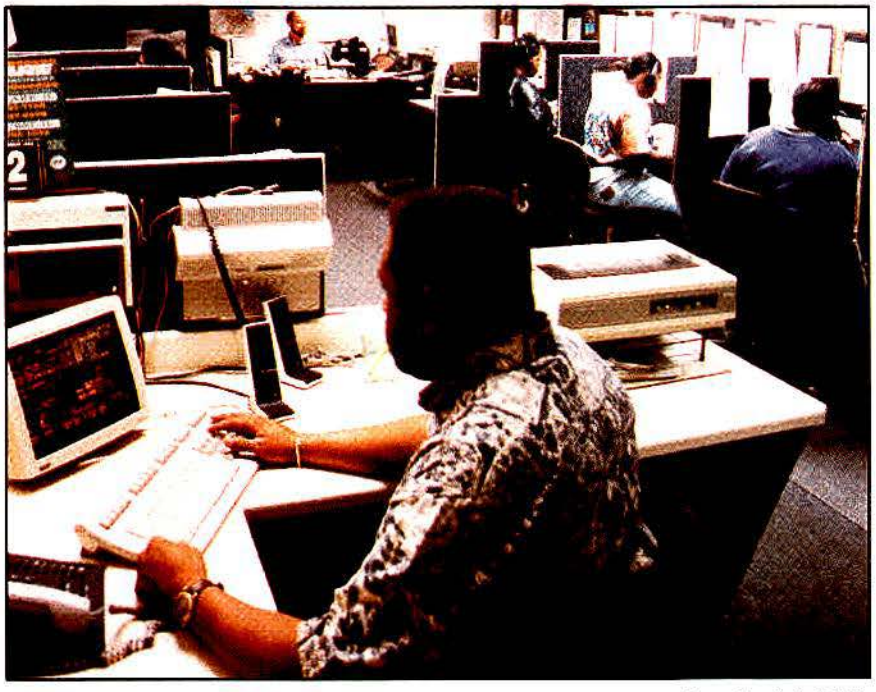
**Controlling the system**

The computerized dispatching system allows the manager to set controls on various aspects of the dispatch operation. The controls define exactly how certain situations are handled. The computer carries out programmed instructions when a control is violated.

These controls customize the system to exact requirements and administer the taxi company's operating policy. Controls are set in motion from one display screen, similar to the one shown in Figure 3 on page 20. All controls are variable, and they can be adjusted at any time.

Once a control is set, any occurrence that exceeds the limit of the control is brought to the operator's attention. The operator can then investigate the cause of the problem and take action.

Controls can be used to track the drivers' performance and to identify system misuse. If a driver exceeds a preset control limit, the infraction is brought to the



**A taxi dispatch supervisor in Chicago uses the Cabmate dispatch system from Gandalf Mobile Systems. Calltakers are in the background. The cab companies, Checker Taxi Association and Yellow Cab, operate about 800 vehicles.** ***Photo by Janusz Gryglak.***

operator's attention. If warranted, the operator can suspend the driver. If a driver is suspended, the system does not dispatch fares to that driver until the suspension is lifted.

### Dispatching fares

Because dispatch methods vary from company to company, the system has flexibility to accommodate *broadcast, closest vehicle* and *first-in-first-out* dispatch methods.

When voice communication is preferred for dispatching fares, a computer-aided voice dispatch (CAVD) system can be used. It automates the order entry and dispatch process and provides a management tool.

The data dispatch system uses mobile data communications to exchange information between the dispatch office and the vehicles. Regardless of which dispatch method is chosen, the fleet management and automated order entry functions are virtually identical.

All operators share the computers and the information that they contain to ensure access to information exactly as it was originally entered, without discrepancies.

### CAVD dispatching

Computer-aided voice dispatching can be added to any conventional voice dispatch system to improve fleet management and dispatch operations while using existing voice communications. The computer tracks customer calls and the vehicle locations. It can provide suitable matches of fare and vehicles and reduce dispatching time.

When a customer requests service, the calltaker enters fare details into the computer using an automated order-entry process. The computer records the fare details and places the fare into a queue within the pickup zone.

The dispatcher uses a two-way radio to communicate with the drivers and a terminal to enter information into the computer. Drivers report which zone they are in, and the dispatcher enters their locations into the computer. The computer then organizes the vehicles into queues.

The computer displays a list of the fares and vehicles in each zone. The dispatcher reviews this information and uses the radio to dispatch a vehicle to a fare.

The driver then proceeds to the customer's location. When the customer gets into the vehicle, the driver relays the pickup information to the dispatcher, and the dispatcher then enters this information into the computer.

When the fare is completed, the driver contacts the dispatcher, and the dispatcher enters the drop-off information into the computer. The computer then removes the fare and the vehicle from the active system.

### Five generations of taxi dispatching

- *1910s–1920s* — call-box telephones.
- *1930s–1940s* — mobile radios with electron tubes.
- *1950s–1960s* — solid-state mobile radios.
- *1970s–1980s* — basic computerized dispatching.
- *1990s* — integrated dispatching using computers, operating systems, application software and mobile data technology.


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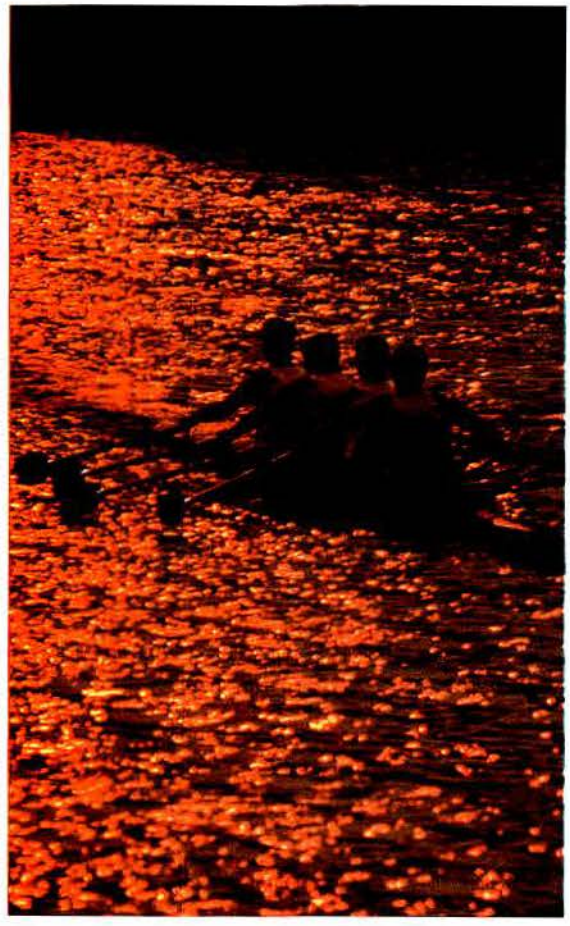
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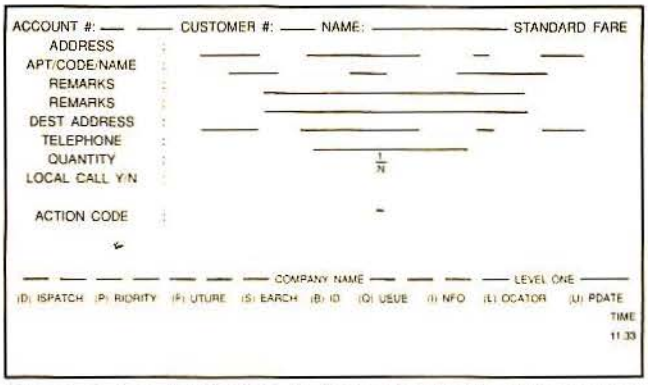



**Figure 1. Each calltaker's video display terminal displays fill-in-the-blank forms similar to the one above. This form prompts the calltaker to enter as much information as possible and ensures that the details are consistent and accurate. The computer sorts, records and stores the fare.**

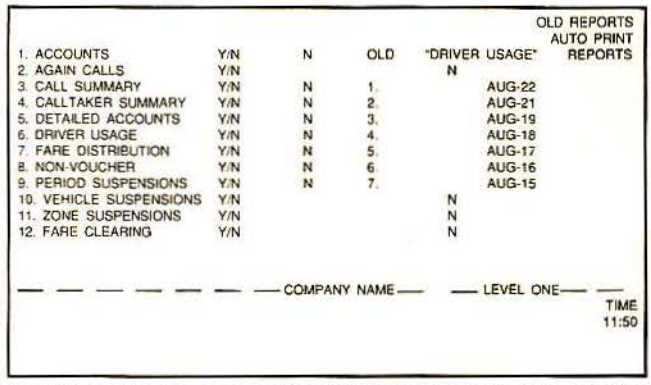



**Figure 2. The system can provide detailed reports to help with managing the taxi company. Specific reports are selected from a list on a display screen, similar to the one above. Each report provides a detailed accounting of a particular part of the operation. These reports can be used to identify and analyze areas that are working well and those that need improvement.**

The computer stores details of the entire process. If the need should arise, operators can retrieve details of any fare previously entered into the computer.

### CAVD dispatch methods

CAVD can organize and dispatch fares in three ways.

▶ *Manual dispatching* — Fares in each zone are placed in separate queues, and the dispatcher manually tracks available vehicles. Each zone's fare queue can be displayed on the dispatcher's terminal. The dispatcher reviews the queues and matches fares with a vehicles.

Depending on the taxi company's operating procedures, the dispatcher can either match the fare at the top of the queue with the vehicle closest to the fare, or broadcast the fare details over the voice channel and allow all vehicles to respond.

Once the fare has been matched to a vehicle, the dispatcher enters the information into the computer, and the fare is cleared from the queue.

▶ *Intervention* — With intervention dispatching, the dispatcher enters vehicle information directly into the computer. The computer sorts the vehicle information in the same manner as the fare information


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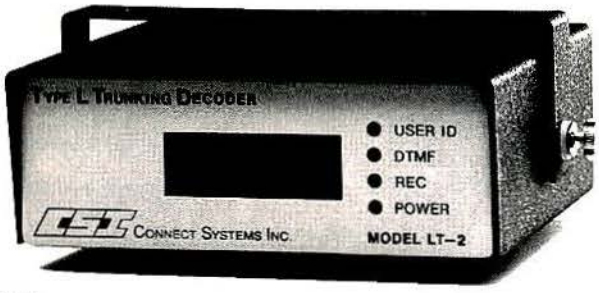
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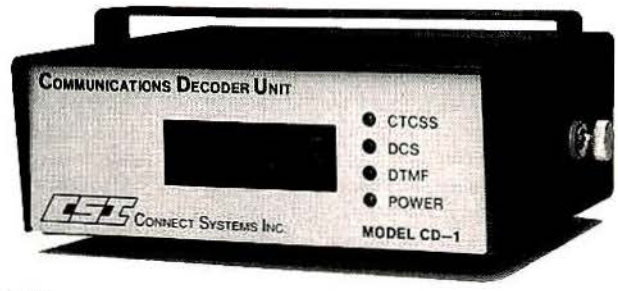
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and generates a vehicle queue for each zone.

Each zone's fare queue and vehicle queue can be displayed on the dispatcher's terminal. The dispatcher reviews the queues and matches each fare with an available vehicle, and then calls out the details over the voice channel to the appropriate vehicle.

▶ *Automatic dispatching* — The most efficient and impartial method of dispatching fares is to let the computer match fares in the fare queues with vehicles in the vehicle queues.

With automated dispatching, the computer automatically generates a fare-and-vehicle match based on information entered by the calltaker and vehicle information entered by the dispatcher. The computer displays matched queues on the dispatcher's terminal, and the dispatcher calls out the information over the voice channel to the appropriate vehicle.

The dispatcher can override the computer's automatic match, if necessary.

### Computerized dispatch system functions

- ☐ organizing the service area.
- ☐ automating the fare entry process.
- ☐ managing the taxi company's operation.
- ☐ controlling the taxi company's operation.
- ☐ dispatching fares.
- ☐ communicating with the vehicles.

**Data dispatching**

With data dispatching, the system automates the dispatching process. Unlike CAVD, which relies on a dispatcher to call out fare information using voice communication, data dispatch sends and receives fare information by data communications.

A mobile data terminal (MDT) is installed in each vehicle and is connected to the vehicle's existing mobile radio. The dispatching computer is connected to the existing base radio. The MDT allows the driver to communicate directly with the computer, and vice versa.

When a customer requests service, the calltaker enters fare details into the computer using the automated order entry process. The system records the fare details, determines the zone where the pickup is located (using a built-in street directory) and assigns the fare to a vehicle in that zone. The computer transmits the fare details to the appropriate vehicle through the two-way radio system.

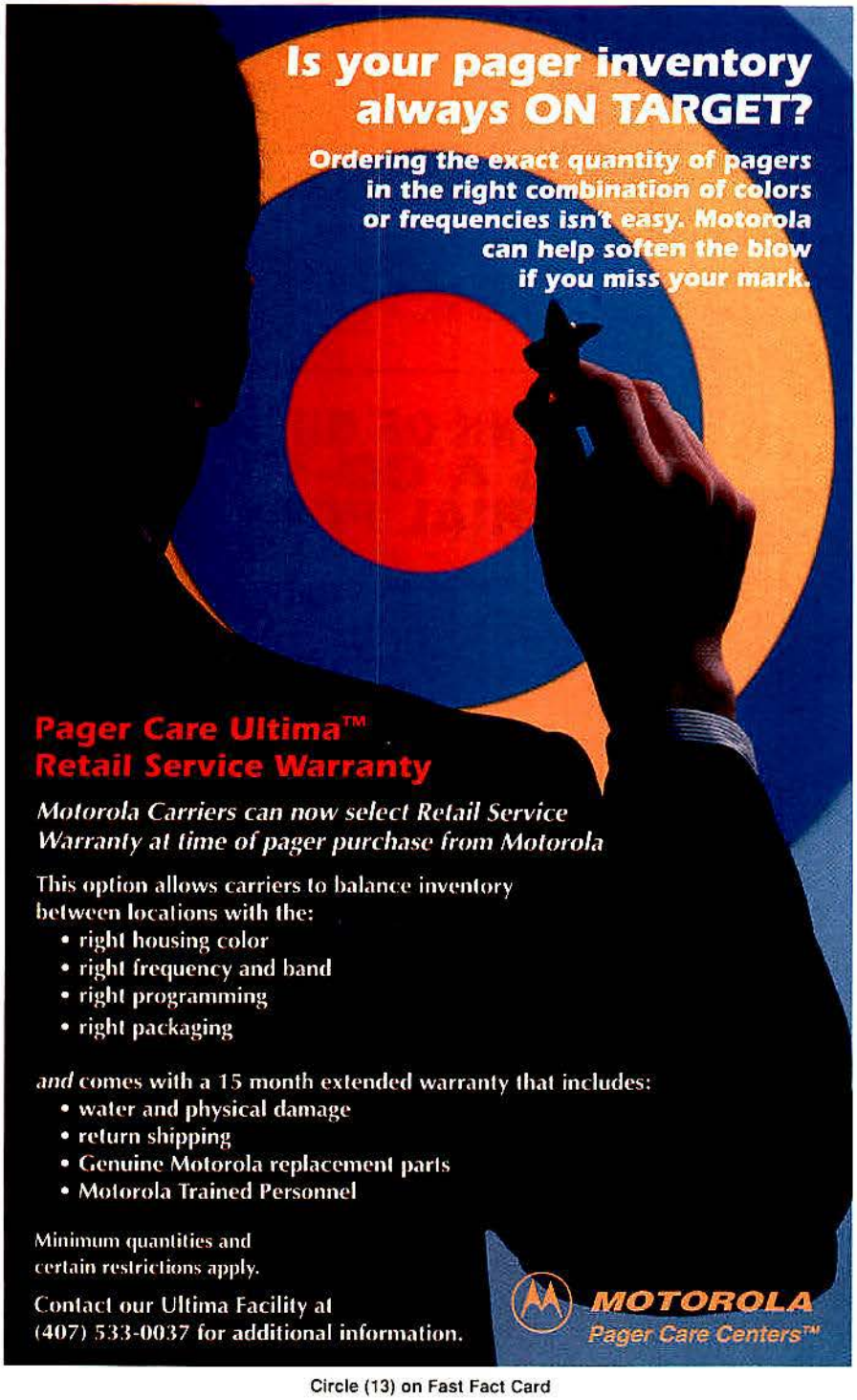
Drivers indicate their locations by entering a zone number into the MDT and transmitting it to the computer. When a fare is dispatched to a vehicle, the MDT receives the information, alerts the driver and displays the pickup details on the MDT's display. The driver acknowledges the fare by pressing a key and proceeds to the pickup address shown on the display.

All pickup and drop-off actions, such as turning the meter on and off, are monitored by the MDT. When the driver performs one of these actions, the MDT automatically transmits the information to the computer.

With the drop-off action, the computer clears the driver from the fare and allows the driver to request another fare.

**Dispatch methods**

The computer matches a fare with a vehicle, and then transmits the fare details

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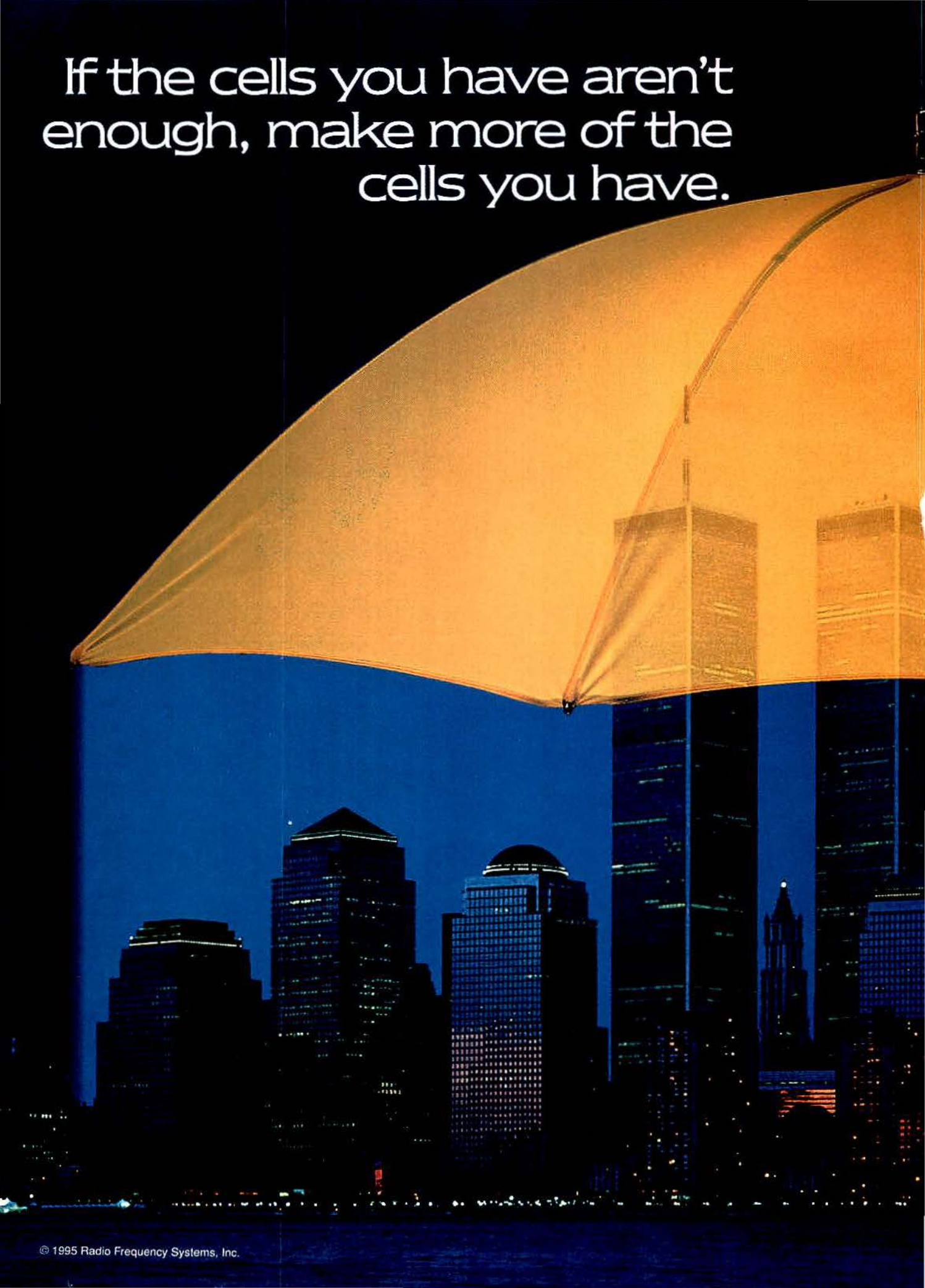
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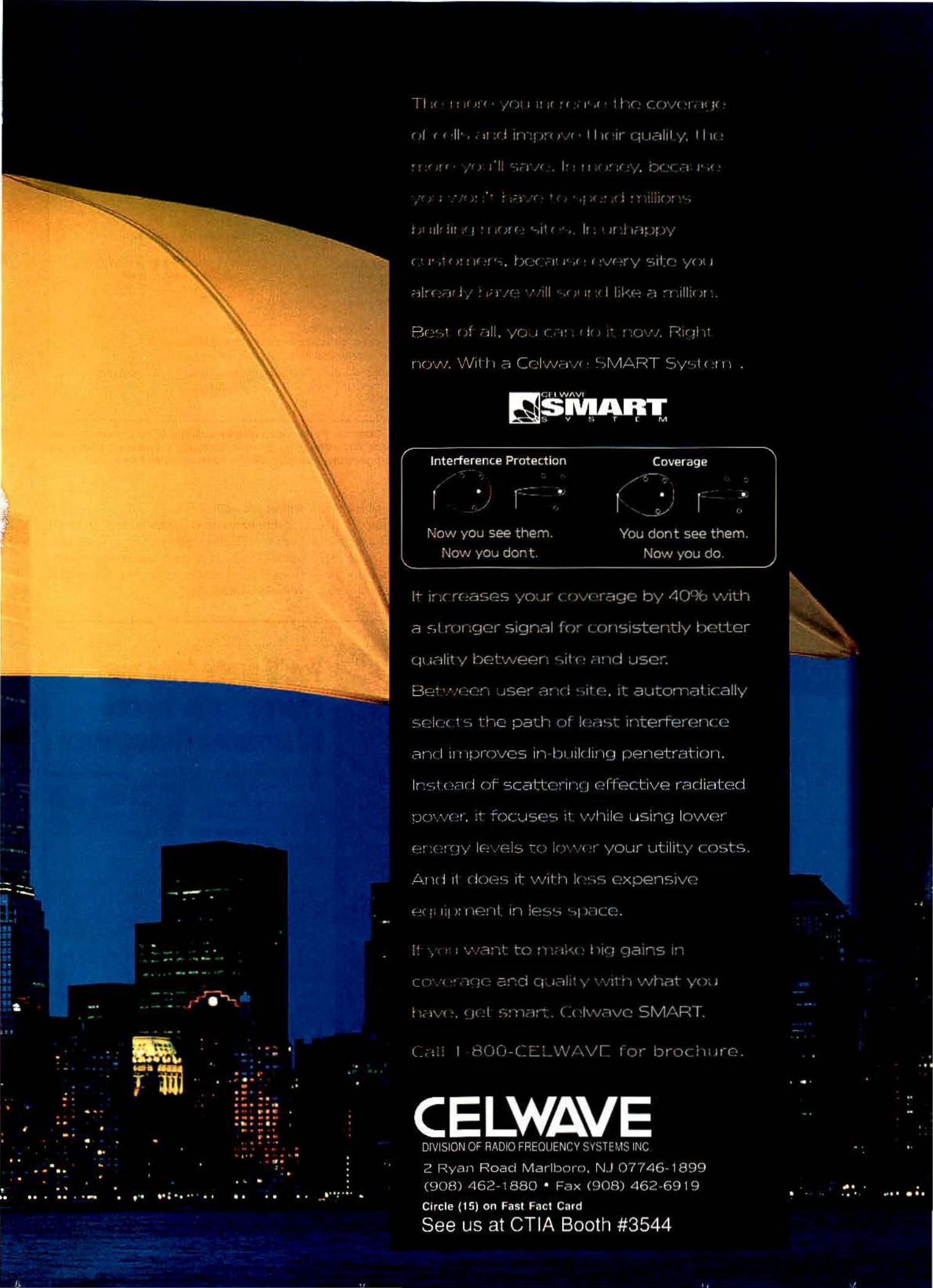
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Bob Teer, an independent driver who owns a Yellow Cab taxi in Des Moines, IA, uses a mobile data terminal to read how many taxis are in a particular part of town and the number of people who want a cab. *Courtesy of* The Des Moines Register. *Photo by Bill Neibergall.*

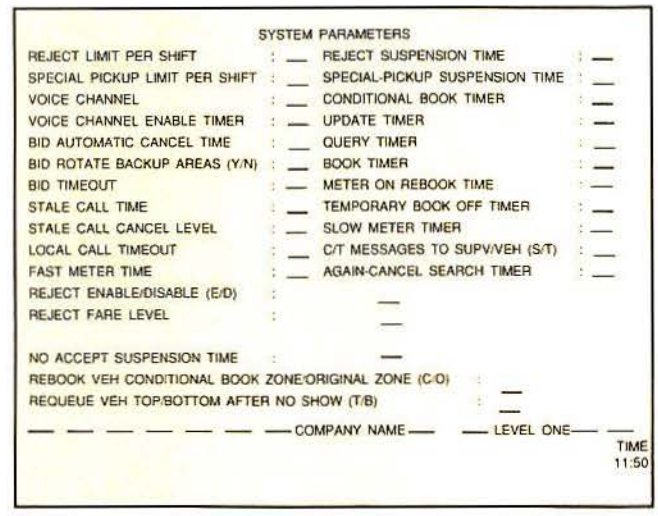



Figure 3. Controls on the video display customize the system to exact requirements and administer the taxi company's operating policy. All controls are variable, and they can be adjusted at any time.

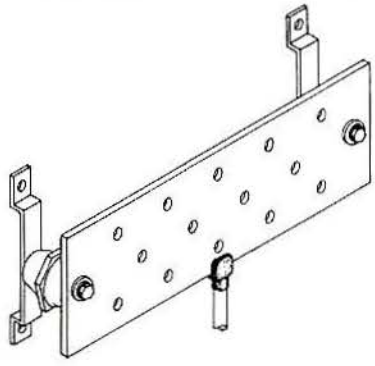
to the appropriate vehicle. This method is called *matched queue dispatching*.

The computer maintains one queue for the fares and one queue for vehicles for each zone in the service area. The fares and vehicles are placed in their respective queues according to the order in which the computer receives the information.

The computer dispatches fares on a *first-in, first-out* basis; that is, the fare at the top of the fare queue is matched to the vehicle at the top of the vehicle queue, within the same zone.

Sometimes it is better not to treat all fares or vehicles equally. The system recognizes this fact and can make exceptions for specific types of fares and vehicle situations.


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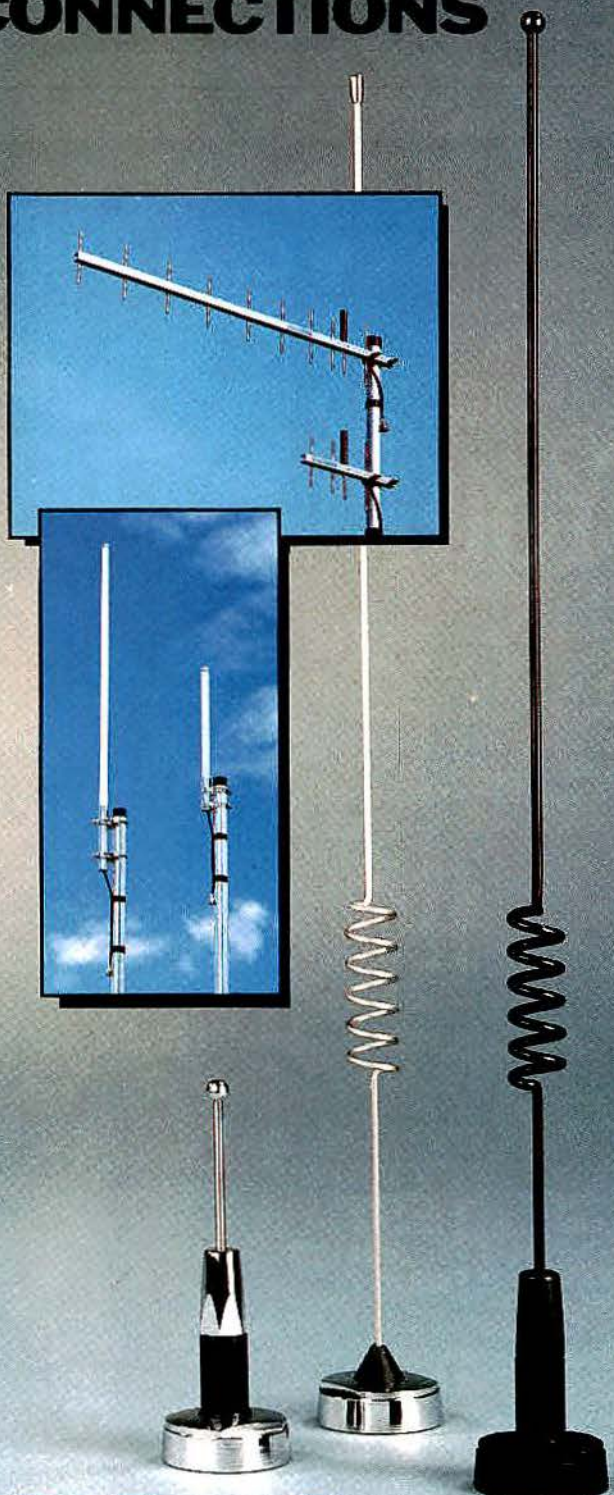
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**Circle (17) on Fast Fact Card**

To accommodate exceptions, the fare and vehicle queues are divided into several distinct areas, and each area is assigned a priority level.

These areas and their priorities can serve a number of purposes. For example, for account customers who order vehicles on a regular basis, fares can be assigned to a high-priority area of the fare queue. Ordinary cash fares may be assigned to a lower-priority area of the fare queue.

When dispatching the fares, the computer dispatches the higher-priority areas first, followed by fares in lower-priority areas, regardless of when the calltaker entered them.

The same principal can be used for the vehicle queues. For example, if a driver is assigned to a fare, and the customer does not show up at the pickup address, the system can be set up so that driver is given priority treatment the next time a fare is available.

These exceptions allow the dispatching process to be customized.

**Communicating with vehicles**

The major difference between CAVD and data dispatching is the way fare information is communicated. Both use any existing conventional mobile radio system for communications. Data dispatching uses the radio system for data communications, whereas CAVD uses it for voice communication.

Data dispatching does *not* require special data radios to operate on a conventional radio system. It can connect to virtually any existing base and mobile radio.

Because data dispatching transmits data continuously (as opposed to intermittent voice communication), the appropriate federal radio transmitting license is required.

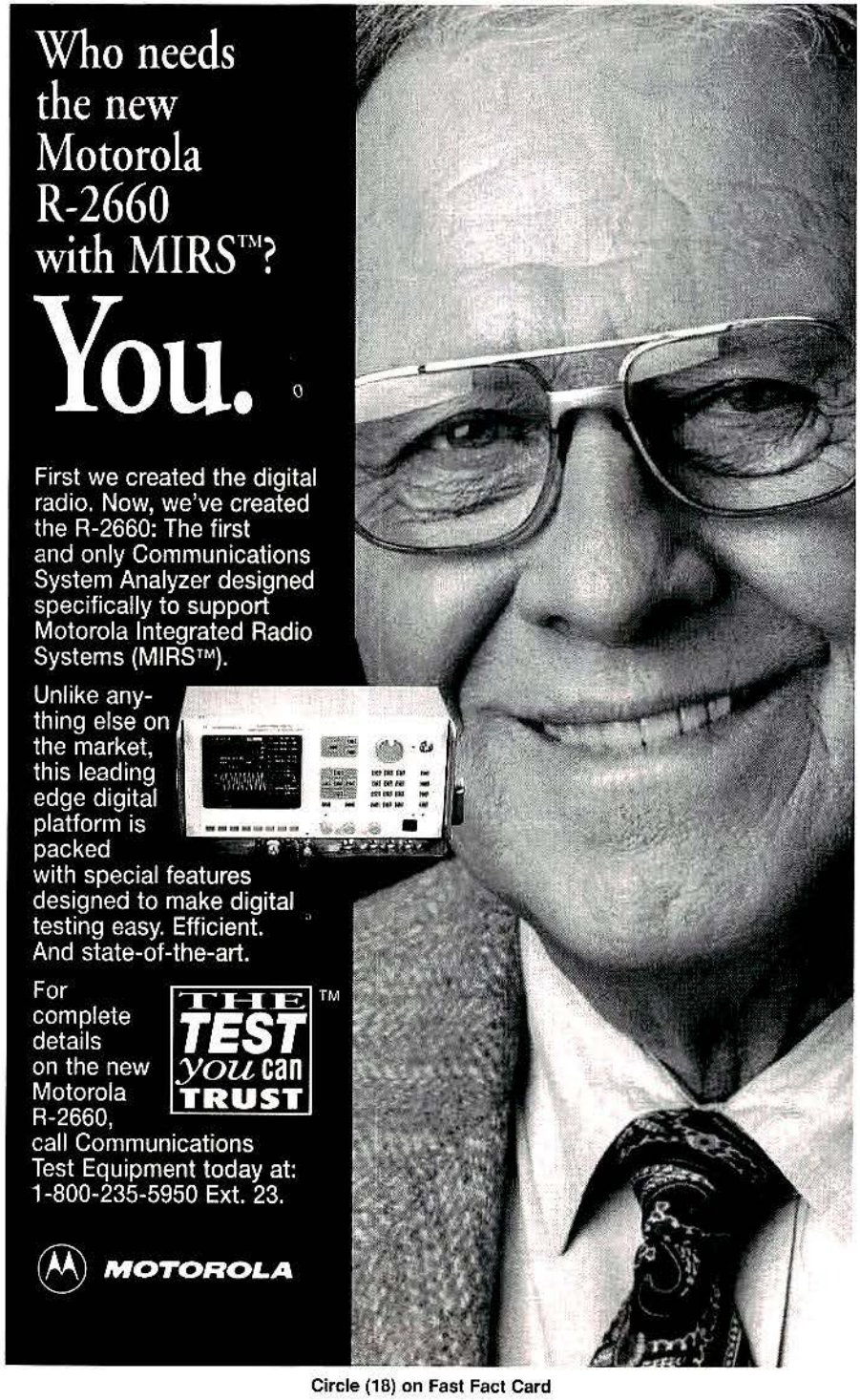
*. . . if a driver is assigned to a fare and the customer does not show up at the pickup address, the system can be set up so that driver is given priority treatment the next time a fare is available.*

**Data vs. voice**

There is a difference in the way that computers and humans communicate, though, and that makes a difference in the kind of equipment needed for data communications.

Computers exchange digital information consisting of individual electronic pulses in a *high state* or a *low state*. When the computer strings pulses together, the high-low sequence forms a data pattern. To a computer, data are like a language. When two computers speak the same language, they can communicate.

Conventional radio systems, such as the taxi industry uses, can transmit a human voice across a wide area. The human voice is an analog signal of continuously varying levels and intensities. The conventional radio system is specifically designed to transmit this type of signal.

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This is where the difference in voice and data communication comes into play. Because conventional radio systems are designed for analog signals, they are not necessarily good at transmitting data. For example, it is impossible to transmit data directly over a conventional radio system without severe signal decay.

Data first must be converted by a *modem* into an analog audio signal. With data dispatching, there are modems at both ends of the radio system. One modem is in a base signaling unit (BSU). The BSU is connected between the base radio and the dispatch computer. It allows the dispatch computer to communicate over the radio system through the existing base radio. Other modems in each MDT allow the MDTs to communicate over the radio system through the existing mobile radio.

All modems perform bidirectional conversion; that is, the modem converts outgoing data to an analog signal, and incoming analog signals to data.

Once data are converted to an analog signal, they have the same characteristics as a human voice. Because of this similarity, the radio system's coverage area normally is the same for data communication as it is for voice communication.

**Data communications efficiency**

The big difference between voice dispatching and data dispatching is efficiency. Data dispatching can dispatch more fares per hour than any voice dispatcher.

In a typical voice dispatch system, it takes the dispatcher about 30 seconds to prepare a fare, to contact a driver and to call out the fare details.

With data dispatching, the computer matches the fare with a vehicle and dispatches the fare by data communication in a matter of seconds.

**Data communications privacy**

With data dispatching, a driver uses an MDT consisting of a keypad, display and modem-control unit. The keypad allows the driver to send messages; the display shows messages that the computer has sent to the driver; and the modem-control unit provides a communication interface between the driver and the dispatch computer.

Even though the vehicles share the same radio system, communications between the dispatch computer and each vehicle are private. Privacy is guaranteed by an identification number assigned to each MDT.

The dispatch computer and the MDT use the ID number when exchanging messages. The dispatch computer uses the ID number to identify the specific MDT for which a message is intended. The MDT uses its ID number to identify itself when sending a message to the dispatch computer.

Messages from the dispatch computer are broadcast over the entire coverage area and are picked up by every MDT on the radio system; nevertheless, an MDT can display a message only when its ID number exactly matches the ID number within the message.

When an MDT sends a message to the dispatch computer, it includes its own ID number. The dispatch computer uses the number to identify which MDT sent the message and to keep a record of messages from each MDT.

ID numbers eliminate any possibility of "fare-scooping" by unscrupulous drivers or competitors. They also allow the dispatch computer to keep detailed records of all transactions with the MDTs.


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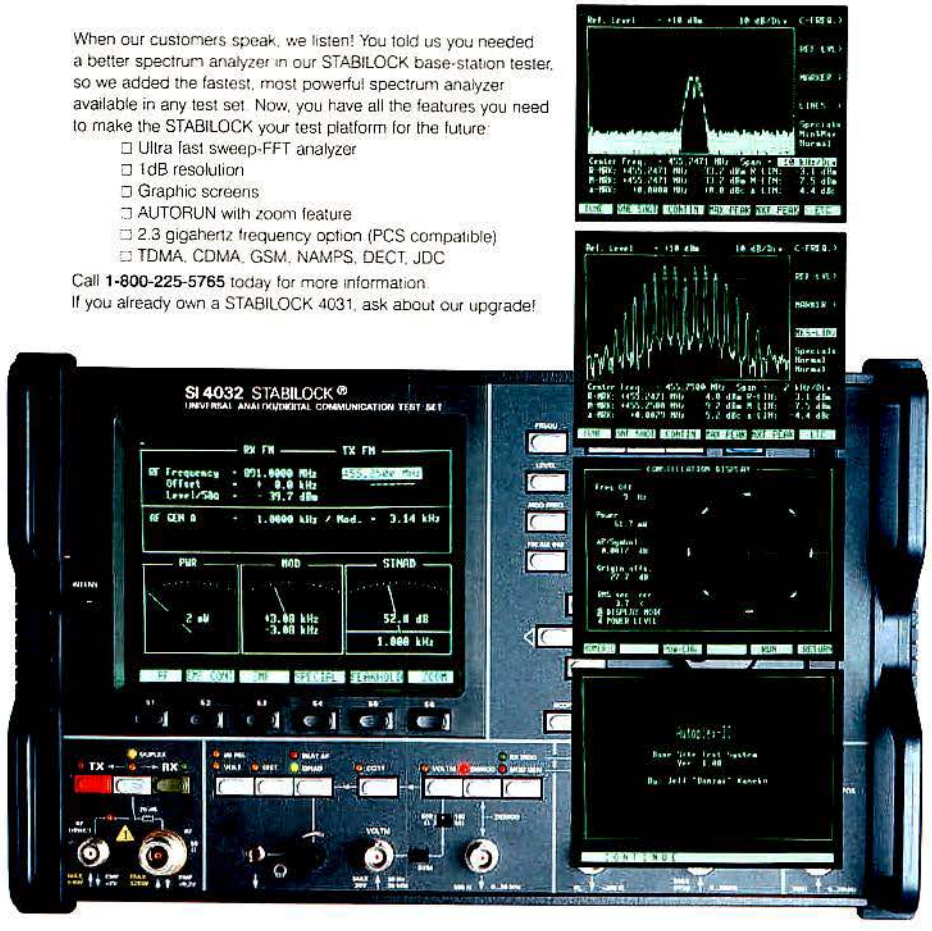
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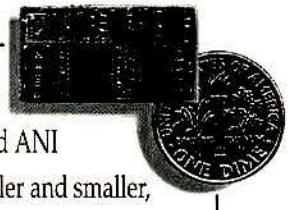

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**Circle (22) on Fast Fact Card**

# Systems maintenance 101: Lightning and verification

*To prevent lightning damage, use distributed protection that includes metal oxide varistors. To reduce maintenance costs, verify the status of component radios before failures can accumulate and become a source of complaints.*

**By Walter Rheingans**

The County of San Luis Obispo, CA, maintains public safety communications systems for many agencies within the county. These systems cover 3,300 square miles, which is quite a large area for a local government.

Communications take place through many standard two-way radio channels. To cover this large area requires eight remote sites, 44 transmitters, 63 receivers and 12 microwave radios to connect them.

The maintenance staff's largest problems include verifying equipment operation and protecting the equipment from electrical current surges.

First, with such a large system and so many channels, large portions of the communications network could fail without the users knowing much was wrong. The communications staff wants to be among the first to know about malfunctions.

Second, maintaining protection from power surges and lightning, with so much equipment exposed at a great distance from the communications repair shop, is a problem.

### Checking

The county has designed a procedure to manage the first problem of verifying equipment condition.

Normal work days begin with a technician visiting the main equipment vault and control point. This technician's responsibility includes rapidly running through a check list, looking for failed voter channels, transmitters that will not key and microwave alarms that are still active. A brief review of the dispatchers' logs and interviewing the dispatchers for complaints completes the check. This process uncovers as much as 85% of the system failures.

A monthly or quarterly remote site preventive maintenance visit uncovers another 10% of the failures. Only about 5% of the system failures are reported by the channel users as a lack of communications ability.

This verification technique is cost-effective for a wide-area public safety system.

Rheingans is communications manager for the County of San Luis Obispo, CA.

**SYSTEM STATISTICS**

| | |
|---|---|
| **Local Sites** | **1** |
| **Link Radios** | **2** |
| **Major Systems** | **5** |
| **Remote Sites** | **8** |
| **Microwave Radios** | **12** |
| **Radio Channels** | **16** |
| **VHF-UHF Transmitters** | **44** |
| **VHF-UHF Receivers** | **63** |
| **Area Square Miles** | **3,300** |

### Protecting

The second problem, power and lightning surges, is met directly. There are two schools of thought on managing primary power protection: *common protection* and *distributed protection.*

The common protection technique applies protection for transient surge and over-voltages at the common entrance point to a communications building. It depends on this installation to protect everything connected "downstream" on the electrical circuits of the building.

In contrast, distributed protection applies or "distributes" the protection to each device used in the communications building.

San Luis Obispo County uses the distributed technique. The distribution of protection is accomplished with inexpensive metal oxide varistors (MOVs).

MOVs are threshold-exceeding, negative-resistance semiconductors. As voltage rises above the rated threshold, the MOV rapidly becomes less and less resistive, essentially providing a short circuit across the power line for voltages in excess of the design limit.

MOVs are *fast.* The typical activation time is measured in nanoseconds (billionths of a second), which is faster than a high-voltage electrical pulse can reach the electronics of the protected power supply and damage the circuitry.

MOVs are inexpensive. In quantities of 100, they cost as little as 73 cents each.

The procedure calls for installing a 140V MOV into each radio unit power supply. The MOVs are packaged as a circular disk with pigtail wires.

### Business plan

The business plan for using MOVs for distributed protection includes the expense of a site visit to replace fuses and MOVs at $63 per hour.

Compare this to the cost of repairing or replacing power supplies and radio circuit modules or subsystem boards. The cost of a 4-hour site visit for fuse replacement and checkout, at $252, is much less than the potential cost of 15 or 18 radio unit repairs at an hour or two each and replacement circuit boards at $125 to $650 each.

Ask your accountant about activity-driven expenses, and you will hear all about designing your system to minimize the activities that drive expenses. MOVs help to keep those activities under control. Keeping the out-of-service time on a radio channel to a minimum is invaluable, and the customers think this is essential.

At all of our remote sites, a technician installs an MOV by wiring its pigtails into a convenient connecting point after the radio's protective fuse. This connection downstream from the fuse ensures that if a

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- Programmable positive & negative squelch output
- CTCSS modulation is programmable relative to ANI
- CTCSS can be held off before and during ANI
- Each memory location can have different CTCSS and/or DCS for encode or decode
- Emergency ANI with repeat delay timer
- Accidental "man down" warning tone timer
- High-pass filter for removing tones from receive audio signal

K ♦ MODEL TDS-2



CTCSS/DCS ENCODER WITH BURST TONE AND ANI

- Encodes standard 83 DCS codes with 134Hz shut-off code
- Encodes 38 standard CTCSS & 13 split tones
- Programmable custom CTCSS, and DCS codes
- Each memory location can have different CTCSS and/or DCS for encode or decode
- Encodes Burst tone with programmable frequency & timing
- Emergency ANI with repeat delay timer
- Accidental "man down" warning tone timer
- Field-selectable positive and negative squelch output
- CTCSS can be held off before and during ANI
- CTCSS modulation is programmable relative to ANI

Q ♦ MODEL TDS/DMH



CTCSS/DCS ENCODER/DECODER WITH BURST TONE AND ANI

- Available with 8 or 16-position switch to select up to 16 memories.
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J ♦ MODEL TCS-2



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- Adjustable audio output level
- Field tunable from 60 Hz to 260 Hz with high stability 15 turn trim pot
- Available with optional small 15 turn trim pot to reduce thickness

Decode features:

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- Wide dynamic input range
- Positive or negative squelch output
- High pass filter removes CTCSS and DCS tone from receiver audio

10 ♦ MODEL TCS-3



SUBMINIATURE TUNABLE ENCODER

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- Encodes all 38 EIA subaudiable tones
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| ECG Phillips | ECG524-31 | 130 | 6,500 | $1.85 |

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large surge current or multiple surges occur, or if lightning hits, the radio unit's protective fuse will open and minimize the damage. For new equipment, the MOV is installed during shop checkout prior to site delivery.

### Zap

When a surge or lightning hits, the damage is usually limited to replacing fuses and checking out the site operation.

Our protected equipment has been damaged only twice. In the 1980s, when this protection program started, a lightning hit destroyed a regulator in a microwave radio battery charger. The unit did not have an MOV installed. Nothing at the site protected with MOVs was damaged, although many fuses were blown.

*When a surge or lightning hits, the damage is usually limited to replacing fuses and checking out the site operation.*

In the same storm, the adjacent tenant, a utility company, sustained the destruction of several power supplies, and many of their radios were out of service for two weeks. The county's systems were returned to service in two hours, including travel time.

In 1993, a power surge hit our Black Mountain site. Although it blew 21 fuses and fried 13 MOVs, it only burned out one receiver audio amplifier. This damage was quickly repaired, and the site was returned to full operation in four hours (three hours of which was travel time.)

### Active program

Managing wide-area public safety communications systems requires an active program to ensure the many radios and channels are always available to the users. This program includes a maintenance program to verify the status of the component radios before failures can accumulate, becoming a source of complaints from the customers.

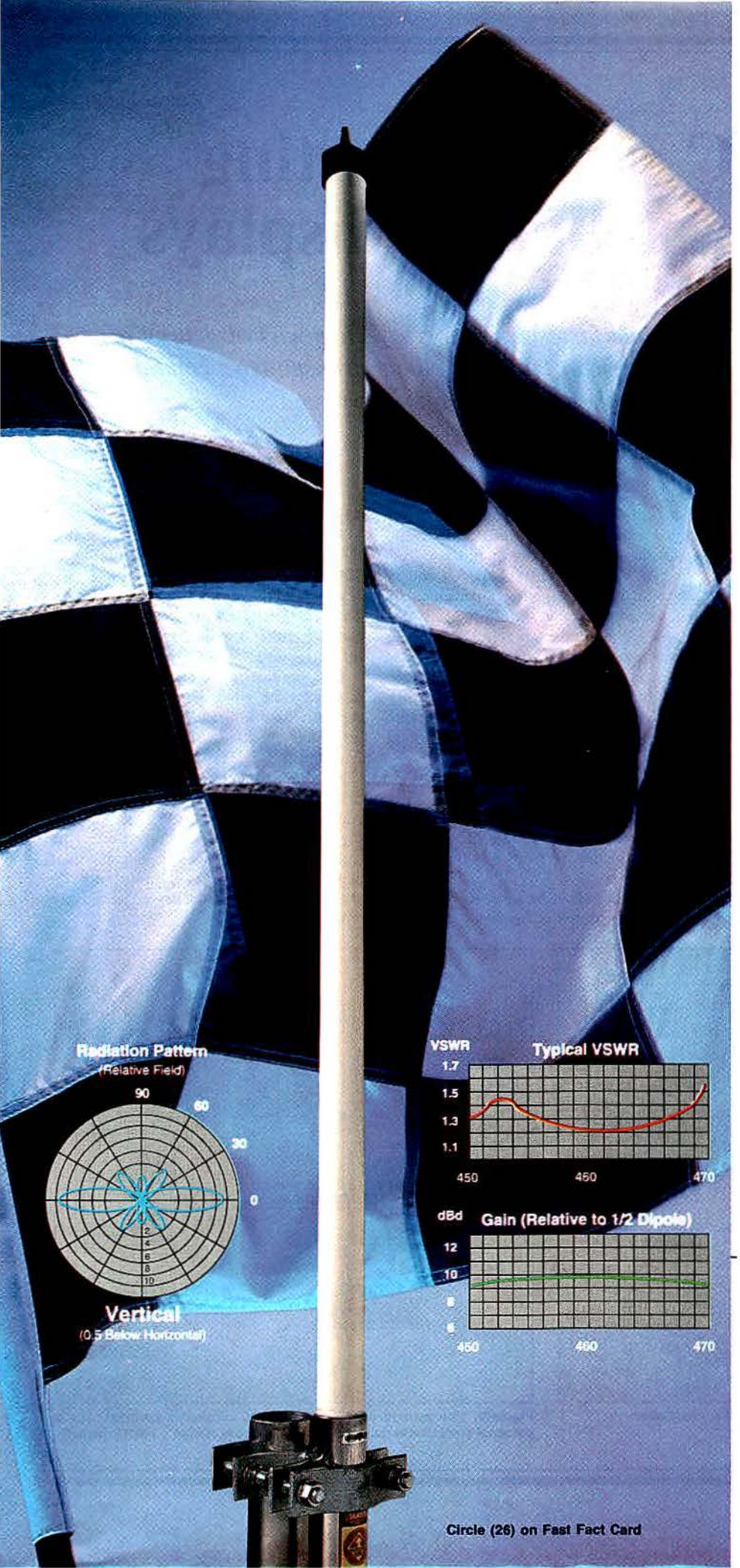
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Circle (25) on Fast Fact Card




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**Circle (26) on Fast Fact Card**

# NADC cell-site testing uses constellation displays

*The constellation display is the fastest and most effective way of getting a quick overview of a North American Digital Cellular transmitter's condition and bringing channels back into service.*

**By Gerhard Mayrhofer**

The constant growth of digital cellular services all around the world, and especially of North American Digital Cellular (NADC) service in the United States, indicates how well accepted this new technology is. NADC is an intelligent approach to digital cellular services. The already-installed Enhanced Advanced Mobile Phone Service (EAMPS) infrastructure can be expanded to NADC service if the subscriber base is expected to reach the maximum capacity of the analog service. Exchanging one analog transceiver with one digital transceiver adds three more traffic channels—with the present full-rate system. As soon as half-rate speech coders are available, yet another three channels will be added for a sixfold capacity increase. The dualmode NADC mobile phones can recognize whether digital channels, analog channels or both are available from the base station. This flexibility means that the NADC user can use the phone in an area with or without digital service.

Mayrhofer is marketing manager, wireless communications engineering, Wavetek, Burlington, MA. All measurements and screen printouts were performed on the Wavetek Stabilock 4031 D service monitor.

## NADC basics

The base station transmit frequency is from 869.04MHz to 895.98MHz; the receive frequency is from 824.04MHz to 850.98MHz.

The duplex offset between the transmitting and the receiving frequency bands is 45MHz.

For compatibility with the "old" analog EAMPS network, channel spacing is 30kHz.

All NADC mobiles are dualmode. This flexibility means that the mobile can use either the analog or the digital infrastructure.

One digital traffic channel is divided into six time slots. For the case of the currently used full-rate speech coder, these time slots are used in pairs (1st and 4th, 2nd and 5th, 3rd and 6th). Three users share one channel frequency with time. With the introduction of half-rate speech coders, it will be possible to further double the capacity of a digital transceiver. This technique is called time-division multiple-access (TDMA) because multiple calls share one channel frequency consecutively with time.

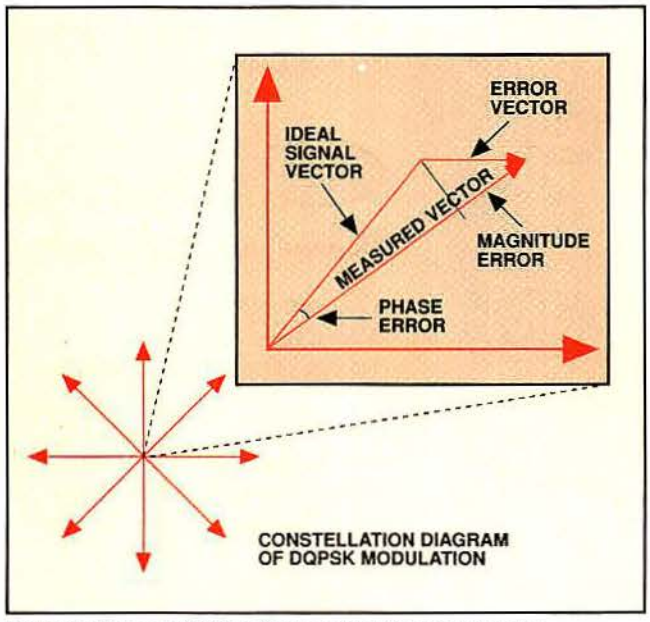



Figure 1. The constellation diagram of a DQPSK modulation.

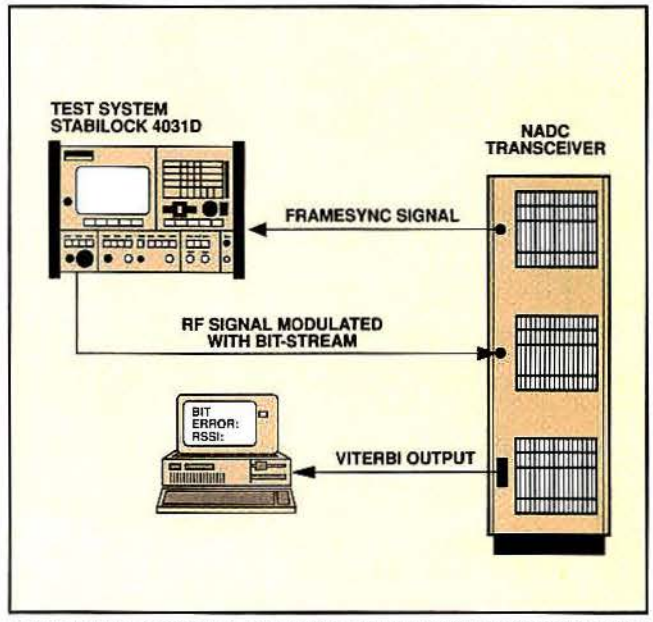



Figure 2. One method of measuring NADC receiver sensitivity uses a personal computer to collect data from the base station's Viterbi decoder.

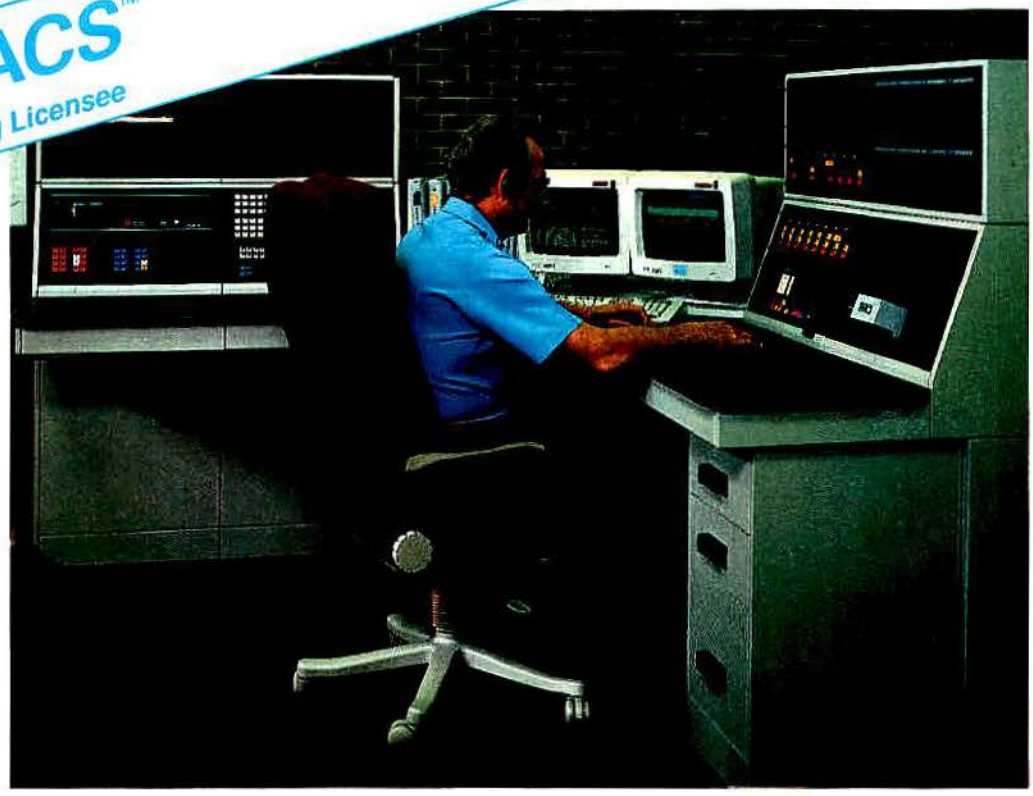
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CALIDA: Big console flexibility for smaller systems



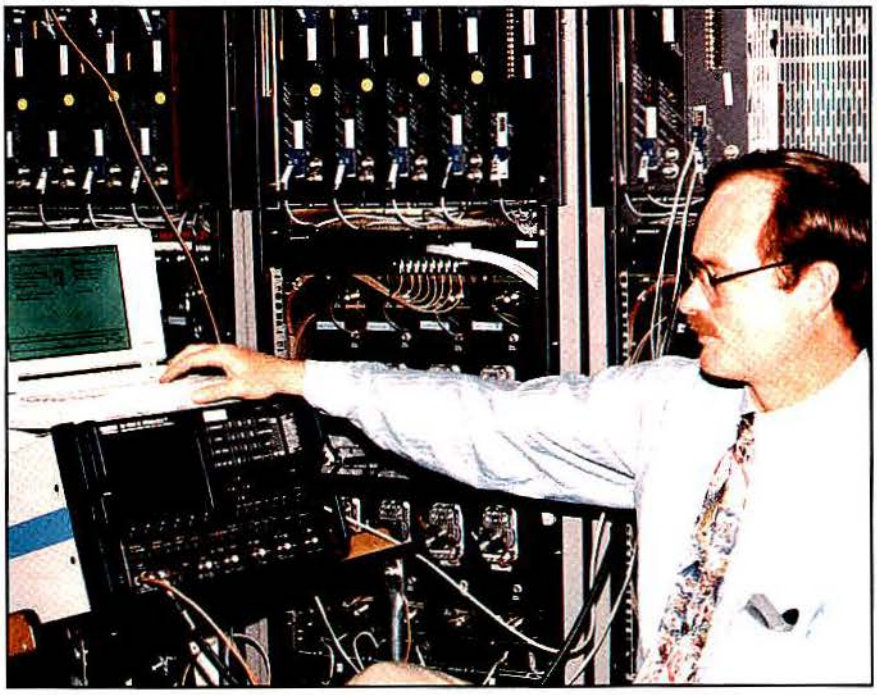
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ORBACOM SYSTEMS, INC.

Circle (27) on Fast Fact Card



A technician uses constellation displays to make test measurements at a cell site.

The modulation used for NADC is differential quadrature phase-shift keying (DQPSK). This modulation process shifts the carrier's phase in steps of $\pm n \times \pi/4$, depending on the symbol changes.

The length of a burst is 6.66ms. This interval is the length of one time slot.

**NADC frame and slot structure**

Six time slots make up one TDMA frame with a length of 40ms.

Each frame carries the information of 1,944 bits (972 symbols, 2 bits per symbol).

The fact that analog and digital channels coexist demonstrates the need for dualmode test equipment. The test requirements for digital channels are different from analog channels. For example, digital channel test procedures include *phase errors, RMS vector errors* and *magnitude errors*. Here are some factors to consider when digital transceivers have to be tested.

**Transmitter Test**

▶ *Vector error magnitude* — Figure 1 on page 30 explains the vector error magnitude in a constellation diagram at the time of symbol determination of a $\pi/4$ DQPSK-modulated signal. The *error vector* is the line drawn between the *ideal signal vector* and the *measured signal vector*. The root-mean-square (RMS) vector error magnitude over one burst is determined from the vector errors of each symbol in a burst.

▶ *Positive/negative phase error* — The phase error is also displayed in Figure 1. It is the phase difference between the *ideal signal vector* and the measured signal vector in degrees. Positive phase error is counterclockwise, and negative phase error is clockwise rotation of the vector about the origin.

▶ *Origin offset* — Measurement of the dc-offset of the I and Q signal, the origin offset, can be considered the digital equivalent of measuring analog signal-to-noise ratio.

▶ *Frequency error* — It is more difficult to measure the deviation of the base station transmit frequency from the nominal channel frequency for a digital channel than with an analog channel.

▶ *Power* — The continuous RF-power from the transmitter is measured with regard for the small amount of AM on this type of signal.

▶ *RMS vector error* — The average error, measured over 162 symbols, includes both the magnitude and the phase error after arithmetic elimination of frequency offset, origin offset and the normalization of power.

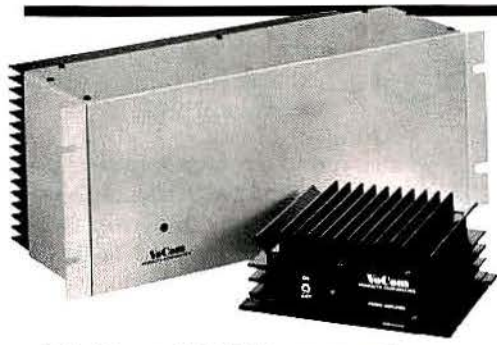
**Receiver test**

▶ *Bit error ratio (BER)* — The BER indicates the digital transceiver's sensitivity. It is the lowest RF level at which the digital receiver can reconstruct the data information. This BER measurement can be compared to the *signal, noise and distortion-to-noise and distortion* (SINAD) ratio check of analog receivers.

▶ *Slow associated control channel (SACCH)* — The SACCH is a signaling channel for transmitting radio control and supervision messages between the digital mobile and the radio network. This channel is called a *logical channel*.

▶ *Coded digital verification color code (CDVCC)* — The CDVCC is a 12-bit information field with 255 distinct values. It is comparable with the supervi-


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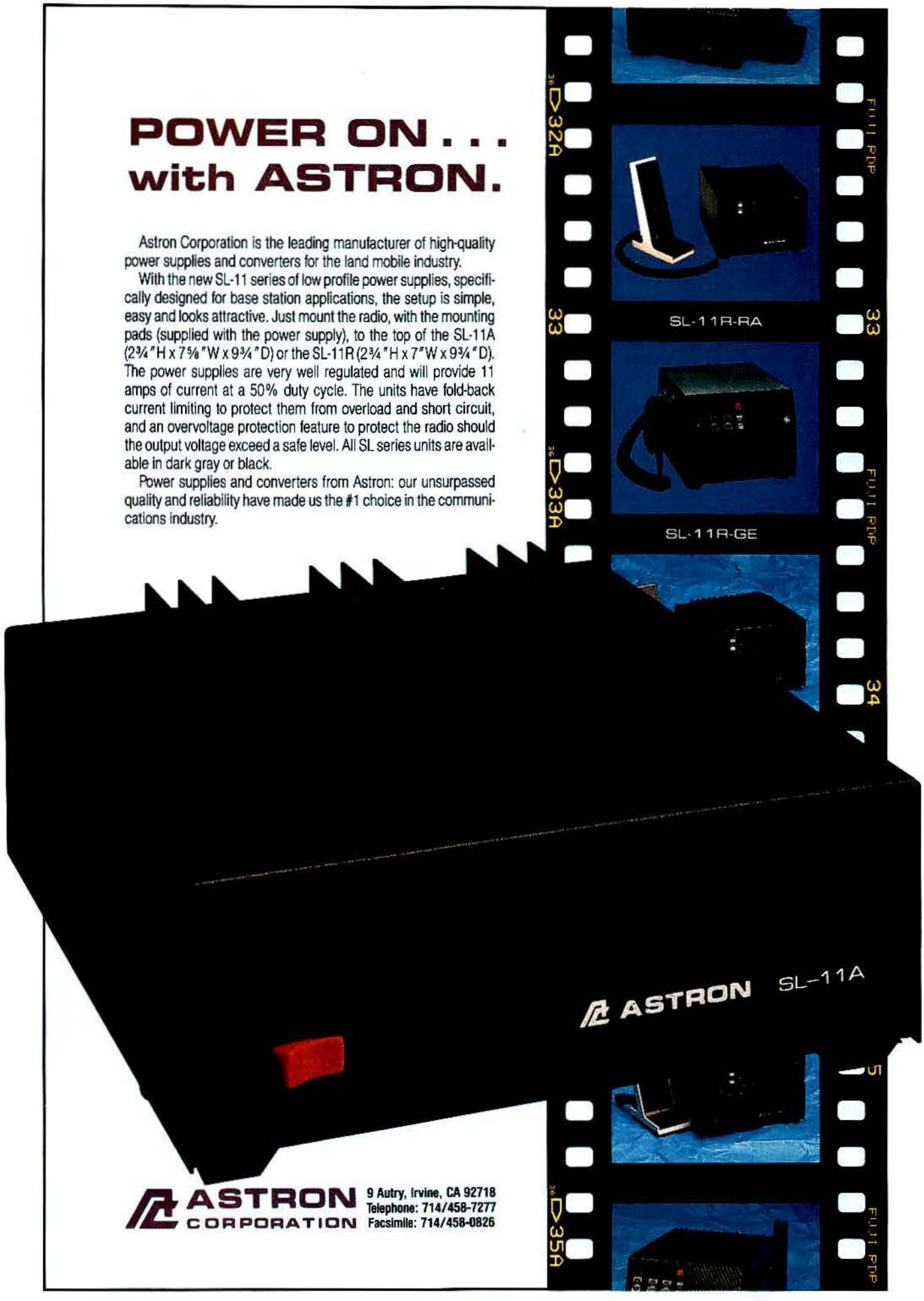
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Figure 3. This is an example of a bit-error mask used in an NADC test system.

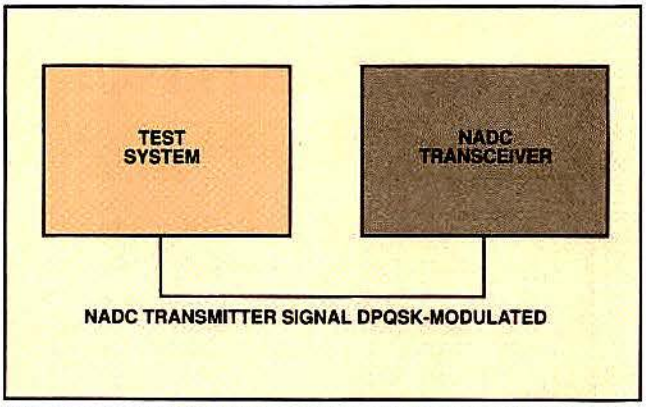



Figure 4. Only one RF cable is necessary to connect a digital transmitter to the test system.

sory audio tone (SAT) in the analog EAMPS system.

**Digital transceiver measurements**

Two major parts have to be checked on a digital transceiver: the receiver and the transmitter.

The most important performance test of a receiver is its sensitivity. The proper measurement for the sensitivity point on an analog receiver is a SINAD measurement, the ratio of signal, noise and distortion-to-noise and distortion at a specific RF level in decibels. Saying this another way, the RF level is decreased until a certain SINAD value is reached.

This measurement is common for analog channels but is impossible to use for digital channels. On a digital channel, the noise and distortion level does not increase comparably with the reduction of the RF level as it does for analog receivers. To measure the sensitivity point on a digital receiver correctly, a bit error ratio measurement is required.

*The bit error rate is the ratio of the number of erroneous bits received to the total number of bits received during an observation period.* This is the definition of BER, according to IS-56.

There are several ways to measure BER, depending on the type of base station. One method is to use a Viterbi decoder to reconstruct the bit information from the RF carrier. The output of the Viterbi decoder (information on how many bits have been

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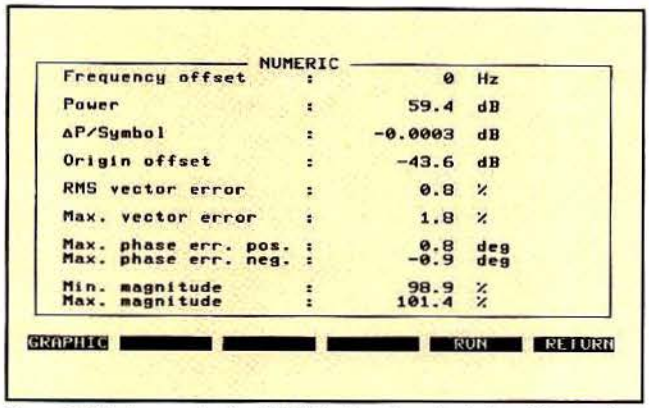



Figure 5. This is a mask of an NADC test system displaying all transmitter test results.

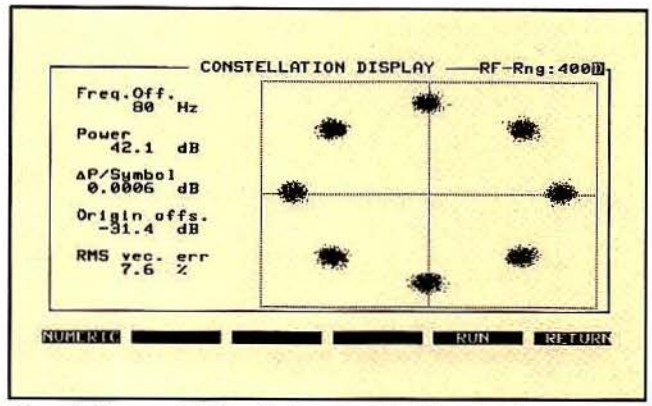



Figure 6. The constellation display of a DQPSK modulation.

corrected) can be taken to calculate the actual bit error ratio.

Figure 2 on page 30 shows one method to perform a receiver sensitivity test on an NADC receiver. The personal computer (PC) collects data from the base station's Viterbi decoder. The test system transmits *valid* (correctly encoded) data via a selectable RF carrier to the NADC receiver. A *framesync* signal is used for TDMA frame synchronization, so that the test system has some indication of the base station's time reference.

Figure 3 on page 34 shows an implementation of a BER mask used in an NADC test system.

Several measurements must be performed on the digital transmitter. The NADC transmitter's RF power and the frequency error are measured as would be done with analog transmitters, except that corrections are made for the AM-like quality of the transmitter.

The most important test on digital transmitters is the modulation quality measurement. This measurement is completely different from analog transmitters. For analog transmitters, you should check deviation, modulation distortion, residual FM and modulation frequency response. With digital transmitters, you should measure phase error, magnitude error, RMS vector error and origin offset.

Figure 4 on page 34 shows how a digital transmitter is connected to the test system with one RF cable. The base station transmitter output connects to the test system

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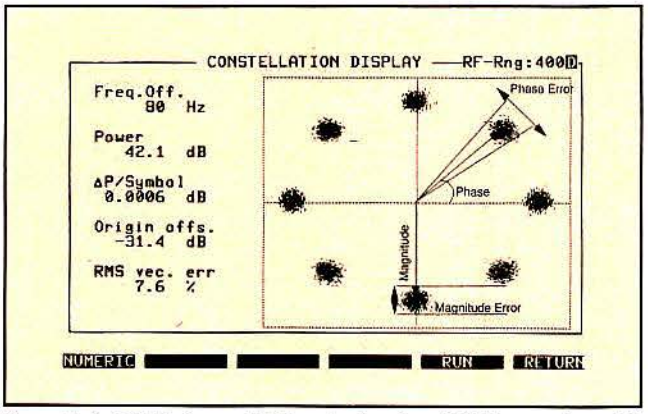



**Figure 7. A statistical constellation display of an NADC transmitter with good modulation quality.**

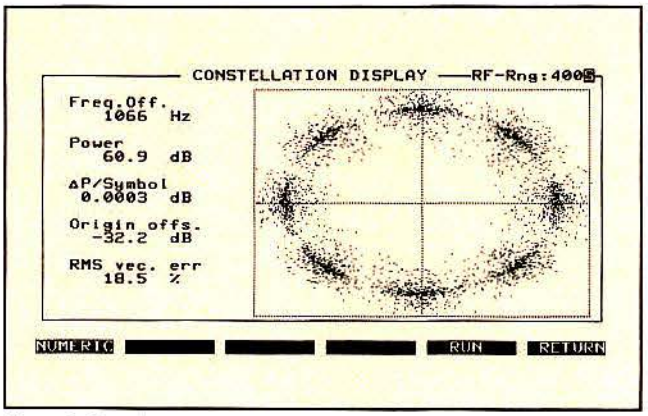



**Figure 8. A statistical constellation display of an NADC transmitter with bad modulation quality.**

power input. When testing analog transmitters, the transmitter's AF input also needs to be connected to the test system. The modulation signal (data) is generated from the digital transceiver in test mode.

Figure 5 on page 35 shows the mask of an NADC test system displaying all transmitter test results. As explained in Figure 1, this numeric evaluation of the transmitter's modulation shows positive and negative *phase error* and minimum and maximum *magnitude*. The most powerful tool to check the NADC transmitter's modulation quality at a glance is the constellation display. The constellation display is generated according to the constellation diagram of the DQPSK modulation. This kind of graphical evaluation will display, within seconds, the complete state of the transmitter's modulation. It shows the relation of *phase error* and *magnitude error* in one graphical display. It makes subtle problems more obvious than they would be with only a numerical display.

The constellation display in Figure 6 on page 35 is unique to my company's service monitors. It offers three evaluation possibilities: the dot, line and statistical modes. The statistical mode is especially important for observing modulation quality over certain periods. This statistical evaluation of the measurement results shows the trend of the *phase* and *magnitude error*, and is valuable in component-level troubleshooting. It brings an analog "feel" to test digital radios.

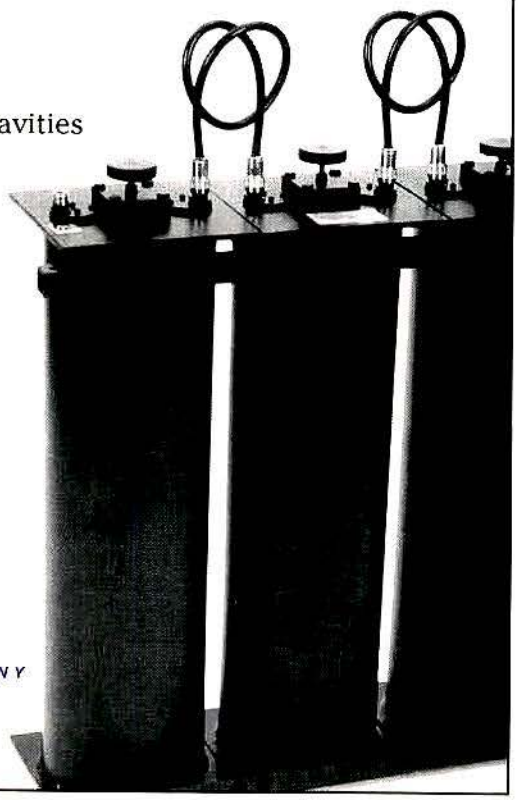
Figure 7 and Figure 8 above show the difference between good and bad modulation quality. Figure 8 displays relatively high *phase* and *magnitude* errors that can result in bad voice quality transmission. Even if the voice quality is acceptable (data can be regenerated in the receiver and decoder), a transmitter with this display needs service. DQPSK modulation is "failure friendly," meaning that if a transmitter modulation phase error becomes too high, the mobile's receiver still is able to reconstruct the bit stream up to a point with its intelligent bit-error correction mechanism. But, if this correction function is working at its limit, the voice quality will turn bad immediately.

Good voice quality is an important issue in cellular mobile radio systems. If the key to a successful system is maintenance, the key to successful maintenance is *speed*, because a cellular channel always is disconnected from the system during maintenance; therefore, it is not providing service and not earning money. To avoid extended system "down time," fast test equipment and procedures are required for maintenance. The constellation display is the fastest and most effective way of getting a quick overview of the NADC transmitter's condition and bringing channels back into service.


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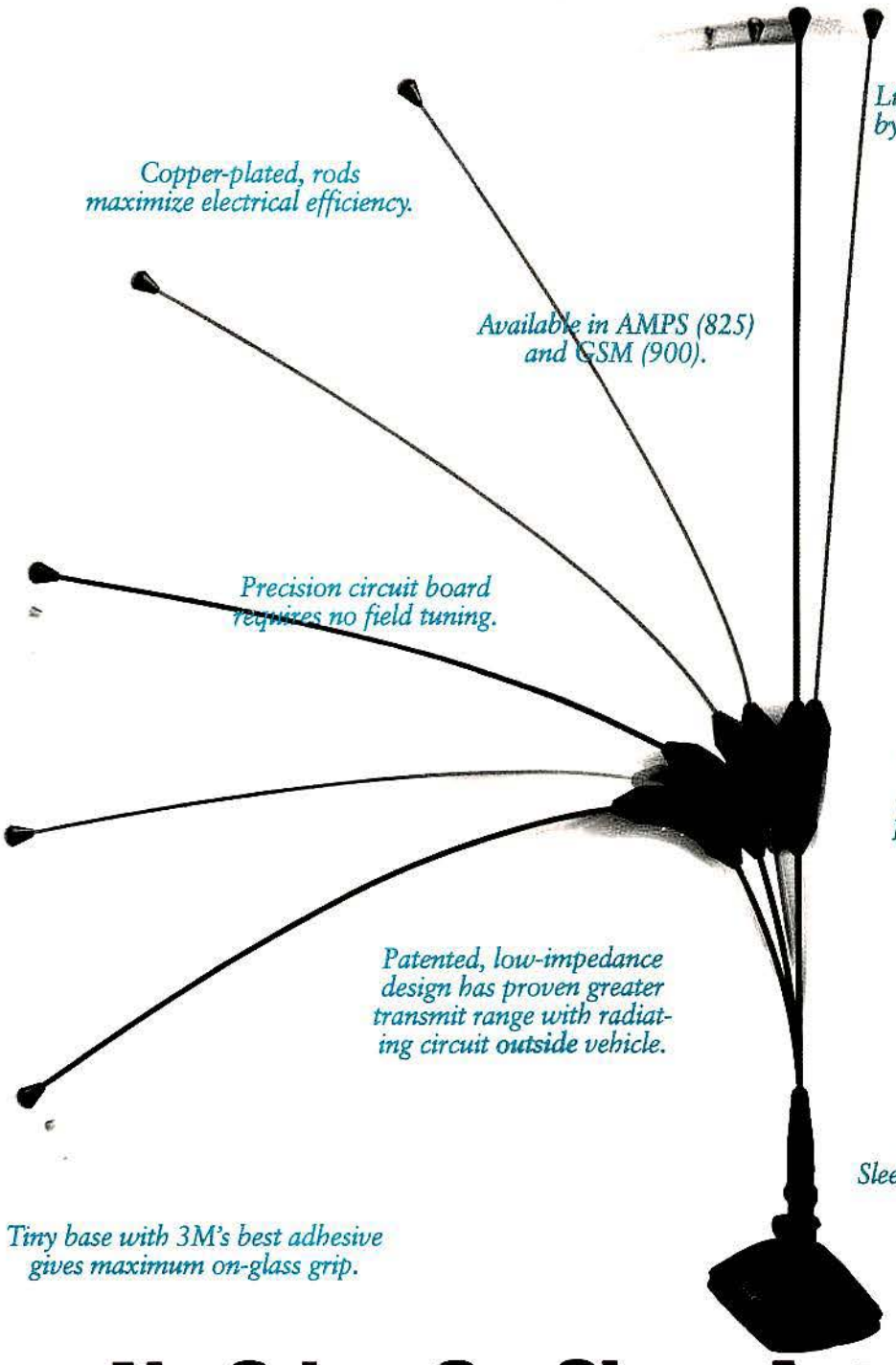
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# Servicing pagers: Mixed signals

*Part 13—Check pager alignment after a customer has used a new pager for a week and listen to the paging system regularly for signs of trouble to make yourself extra valuable to the airtime supplier.*

**By David Ludvigson**

To this point in the pager servicing article series, various pitfalls and problems that occur with Bravo pagers have been discussed. The following information describes some other "disturbances" not previously covered.

After changing a crystal in a Bravo pager, it is wise to have the customer bring the unit back after about a week to check the alignment. There is a natural tendency of a crystal to age, which may cause it to wander from its original frequency. This phenomenon is especially noticeable with Bravo pagers that use 17.9MHz IF receivers operating in the 930MHz range. The operating frequency also is adversely affected by changes in ambient temperatures, so as the seasons change, expect a sudden influx of alignment work orders.

**Beyond local control**

Frequent "hookups" (setting up new customers to receive messages) require a paging network to maintain vast quantities of capcodes and associated telephone lines. Having these, the supplier also must deliver a radio signal to geographic areas that suit the customers' needs. Theoretically, all the equipment and data will provide reliable service—but there may be other problems.

As the reseller's customer base grows, confusion may result: capcodes may suffer from "dyslexia;" pager telephone numbers may be confused or duplicated; and transmitters may fail. More unusual problems may arise, too.

As a paging service grows, the need to expand current services may conflict with the existing structure. Thus, in spite of a technician's loud insistence that "this capcode *has* to be working" (and the network representative asserting that "it should be"), it usually is discovered that expansion (or some other work) has caused inadvertent shut-downs of several capcodes—at the *network's* end. A capcode generator and an alignment of the pager have produced reliable operation, but the switchboard required attention to make the proper connection.

Technicians who are always listening to their airtime suppliers' frequencies usually are quick to notice impending problems. In September 1993, a noticeable "pinging" was heard in a signal from one of Houston's largest airtime suppliers. I suggested that the transmitter's voltage-controlled oscillator (VCO) was introducing distortion. Tests conducted with the transmitter circuitry off-line and under ideal conditions revealed proper waveforms. When the transmitter was placed back on the air, though, the waveform distortion returned. A new VCO assembly was required to tame the problem.

Unfortunately, not all problems are consistent. Tracking the source of countless "error" messages in pagers caused one Houston airtime supplier to lose many of its resellers. Intermodulation distortion was entering the data stream at the satellite receiver and cutting data to ribbons. With the intermittent nature of the problem, tracking the source was extremely difficult. The solution was expensive because it involved new sites and accompanying transmitters.

Sometimes, the problem might be localized. A paging transmitter sometimes will fail, leaving a large territory without service. Listening to the monitor revealed that the distant paging transmitters were operating, but the local one seemed to be dead. A thunderstorm had flooded a transmitter location in south Houston.

Service technicians who take time to listen to their supplier's frequencies can be helpful when they contact service employees at the paging company to report unusual system operation. Remote transmitter monitors may report a system is working fine, but they cannot report the presence of intermodulation distortion. Furthermore, varying weather conditions may also cause signal fading.

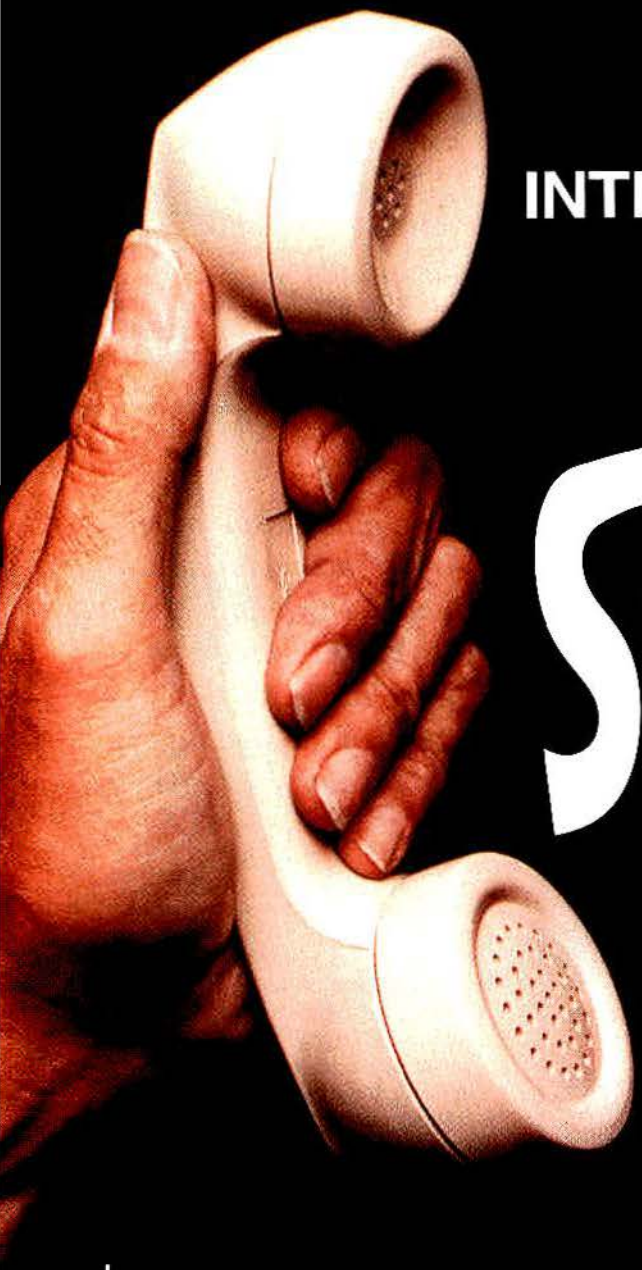
Ludvigson is a technician in Houston.

## Pager servicing series

Part 1: "Build a Shielded Room," January 1994. (All pagers.)
Part 2: "Build An 'IFFER,'" February 1994. (Bravo, Bravo Plus, Bravo Express.)
Part 3: "Frequencies, Coding Formats, March 1994. (Bravo.)
Part 4: "From Bench To Programmer," April 1994. (Bravo.)
Part 5: "The Receivers," May 1994. (Bravo.)
Part 6: "Elegant Simplicity," June 1994. (Bravo.)
Part 7: "Problems In Paradise," July 1994. (Bravo.)
Part 8: "406MHz–512MHz Receivers," August 1994. (Bravo.)
Part 9: "150MHz Receivers," September 1994. (Bravo.)
Part 10: "Tales Crystal Filters Tell . . .," October 1994. (Bravo, Bravo Plus, Bravo Express.)
Part 11: "Microprocessor Board," November 1994. (Bravo.)
Part 12: "Headaches (and Some Aspirin)," January 1995. (Bravo.)
Part 13: "Mixed Signals," February 1995. (Bravo.)

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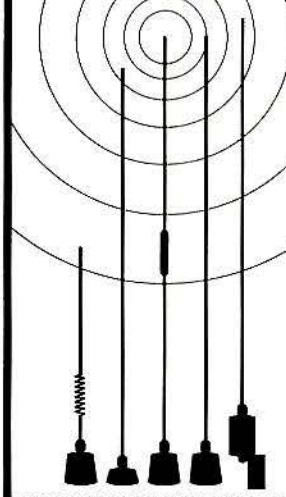
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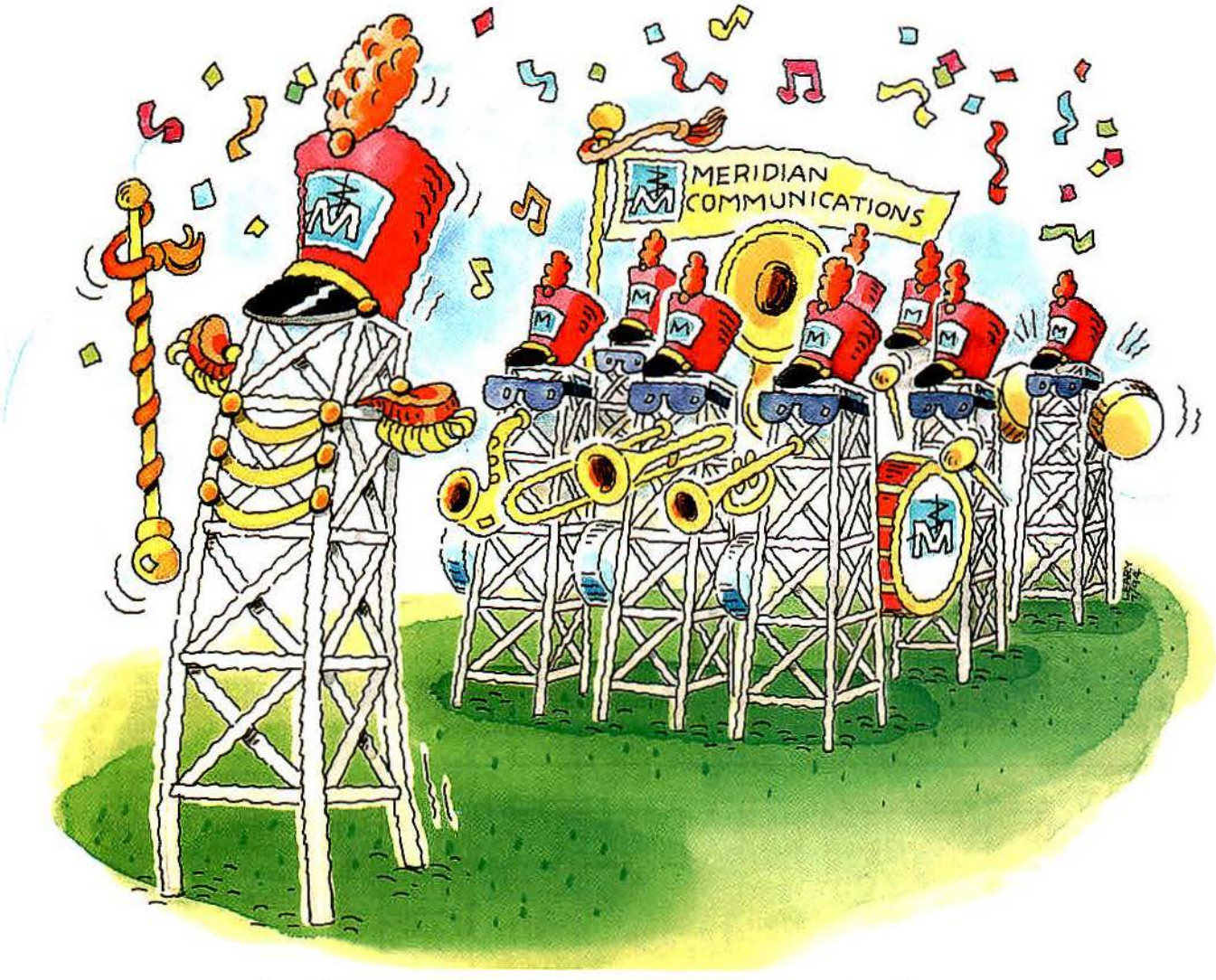
With the proliferation of 930MHz assignments has come the considerable problem of transmitter noise. In heavily populated areas, transmitted signals tend to overlap one another, causing desensitization at the receiving pager. (See "Technically Speaking—Transmitter Noise" by Harold Kinley, C.E.T., in the September 1993 issue, p. 8, for an indication of the headaches that may occur at transmitter sites.) In Houston, where many pager users are often directly *beneath* paging transmitters, channel spacing vs. pager sensitivity may become a critical issue. Receiver designers will attempt to narrow the pager's bandwidth (at the IF) to allow reception in the presence of a strong adjacent-channel signal, but this places stringent requirements on receiver local oscillators for frequency stability.

*Another issue often found in synchronous or simulcast paging systems is the problem of synchronizing the very start of the message at the preamble or comma.*

Another issue often found in synchronous or simulcast paging systems is the problem of synchronizing the very start of the message at the preamble or comma. The alternating 1-0 pattern of POCSAG coding could easily become confusing to a pager located mid-way between two out-of-sync transmitters. At 512bps, this condition could occur in as little as $^1/_{512}$ of a second. It gets worse as the bps rate is increased! Various proposals have been suggested (such as specific codewords) to minimize this problem, although implementation would require a totally new approach, as well as new pagers.

**Acknowledgement**

I would like to thank the management and staff of JJ Sounds & Communications, South Houston, TX, for their help with this project. Tel: 713-944-1813.




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# Volatile RF paths in buildings influence PCS system design

*Variations in how much radio frequency (RF) energy penetrates floors in buildings and how much it is affected by people and machinery in motion will influence personal communications services system designs.*

**By Kenneth W. Evans and Jere T. Sandidge**

Many future personal communications services (PCS) will require adequate radio coverage inside buildings to satisfy customer needs for wireless communications.

Radio frequency (RF) energy transports the information between PCS devices. A complete understanding of the "indoor RF environment" is the foundation for designing PCS networks. This environment includes customer use and preference issues and the administrative and technical issues involved in installing and maintaining an indoor system.

Our company has conducted numerous experiments and trial system operations in an effort to develop such a complete understanding. For example, the Campus PCS Office Trial, conducted in Atlanta, is a 100-cell system that provides hand-off service on the first 11 floors of the 1100 Peachtree St. Building; all but seven floors of the Campanile Building; the food court at a local shopping mall; and selected street locations. These areas resemble a campus because two buildings are across the street from one another. The 150 BellSouth employees who use the system were provided a wireless extension of their office telephone.

Early experiences indicated that the indoor RF environment was much more volatile than expected. To our surprise, this was true even for a stationary user.

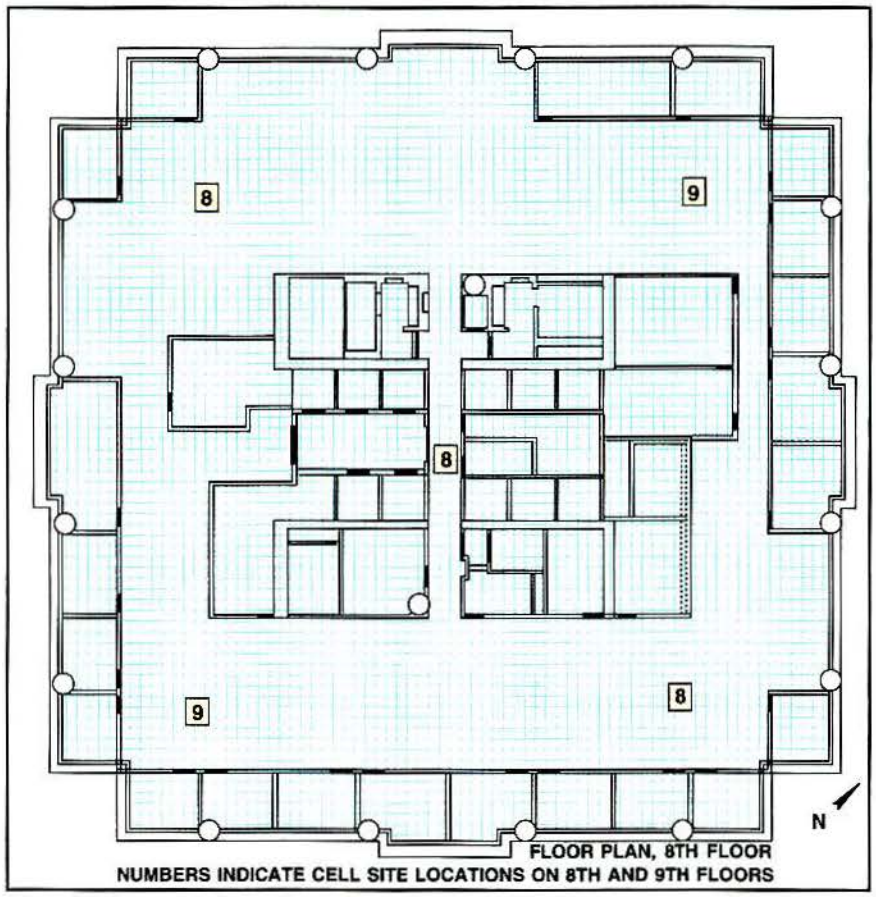



**Figure 1. Cells were deployed diagonally across the eighth and ninth floors—one each in the east and west corners, and one in the middle of the eighth floor. Two cells were then placed on the ninth floor in the north and south corners. The ninth-floor cells were intended to cover the north and south corners of the eighth and ninth floors. They *did* cover the eighth floor, but there was a problem when a user was where two or more cells could adequately handle a call—in other words, where signals overlapped.**

## Indoor RF coverage

Wireless systems are designed to provide ubiquitous coverage within a given geographic area. For a high-rise building, ubiquitous coverage was assumed to mean coverage floor by floor. Interaction *between* floors was not anticipated because it was thought that interaction would be prevented by RF loss through the floor.

Some previous experiments measured the loss through a floor in excess of 30dB in the 800MHz and 900MHz bands. This much loss, combined with other factors, led many to believe that each floor could be designed as a somewhat independent entity.

This conclusion proved to be incorrect in the 1100 Peachtree Building and on most floors in the Campanile building.

The loss between floors was measured at 5dB at 915MHz in the 1100 Peachtree

Evans and Sandidge are senior managers with BellSouth Wireless, a division of BellSouth, Atlanta. Reprinted with permission from BellSouth Wireless, Inc.

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Street building and between certain floors in the Campanile building. The loss differed from previous measurements in other buildings because of construction techniques. Buildings with 30dB or more of floor penetration loss usually have floors built with concrete poured on top of a solid-metal plate. The plate acts as an RF shield.

A floor penetration loss of 5dB is common when the floor is made from reinforced concrete poured into a form that is removed after the concrete sets.

Elsewhere, the floor penetration loss may exceed 30dB where a raised floor has been installed to accommodate computer wiring. The floor tile has a metallic base to reduce static and shield RF. The shielding effect of the floor and the computer cables beneath it increase the RF loss.

Other construction techniques will yield different floor penetration losses, a matter that needs investigation in connection with future PCS deployment strategies.

A service provider probably could take advantage of whatever RF loss occurs between floors to reduce the number of cells required in a given installation. For example, a system might be designed to allow cells on one floor to provide coverage on that floor and the floor below, eliminating the need for another cell.

A deployment strategy was developed at the 1100 Peachtree building to test this hypothesis. Cells were deployed diagonally across the eighth and ninth floors—one each in the east and west corners, and one in the middle of the eighth floor. Two cells were then placed on the ninth floor in the north and south corners. This coverage strategy is depicted in the floor layout of Figure 1 on page 42. The number "8" represents cell placement on the eighth floor, and the number "9," cell placement on the ninth floor.

The hypothesis was that the ninth-floor cells would cover the north and south corners of the eighth and ninth floors. They *did* cover the eighth floor, but there was a problem when a user was where two or more cells could adequately handle a call — in other words, where signals overlapped.

At times, a user would be equidistant from an eighth- and a ninth-floor cell. For example, a user might be in the northeast area of the eighth floor. (See Figure 1). Under these circumstances, the user would be equally distant from the cell in the middle and the east corner of the eighth floor and the cell in the north corner of the ninth floor. RF signals in this overlap area were marginal from all cells. The marginal signals caused the audio to be slightly noisy, but acceptable.

In addition, the hand-off algorithm required the system to select a new cell whenever a stronger RF signal was detected, even though the audio quality was acceptable. In these overlap areas, this algorithm caused a hand-off about every one-to-two seconds, even when the user was stationary.

Noise associated with hand-off degraded the audio quality to an unacceptable level. The interim solution was to add cells to increase the general signal level on each floor. This solution involved placing cells in each quadrant on all floors. A cell was placed in the middle of each even-numbered floor to cover that floor and the one below it, taking advantage of floor penetration.

Initially, we were concerned that the poor audio quality would make the trial participants reluctant to use the system. Such reluctance would have skewed the customer activity data. Adding cells sufficiently improved the audio quality to eliminate this concern. Even so, it did not


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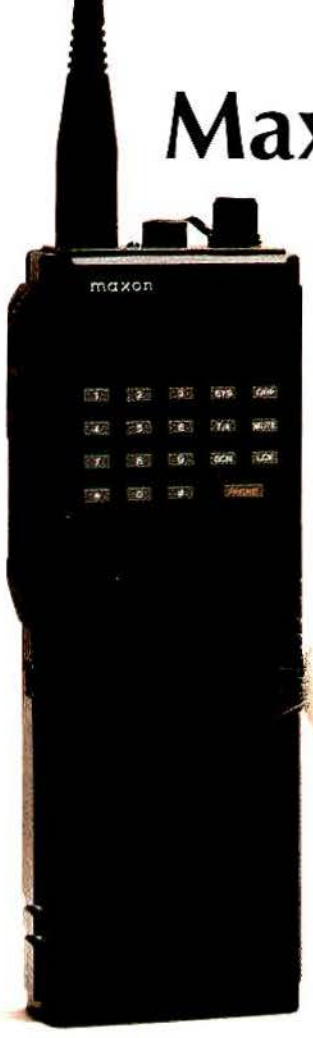
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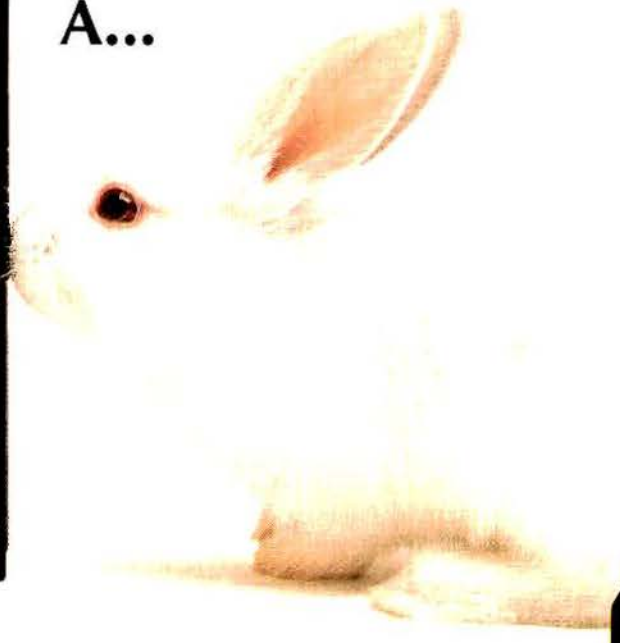
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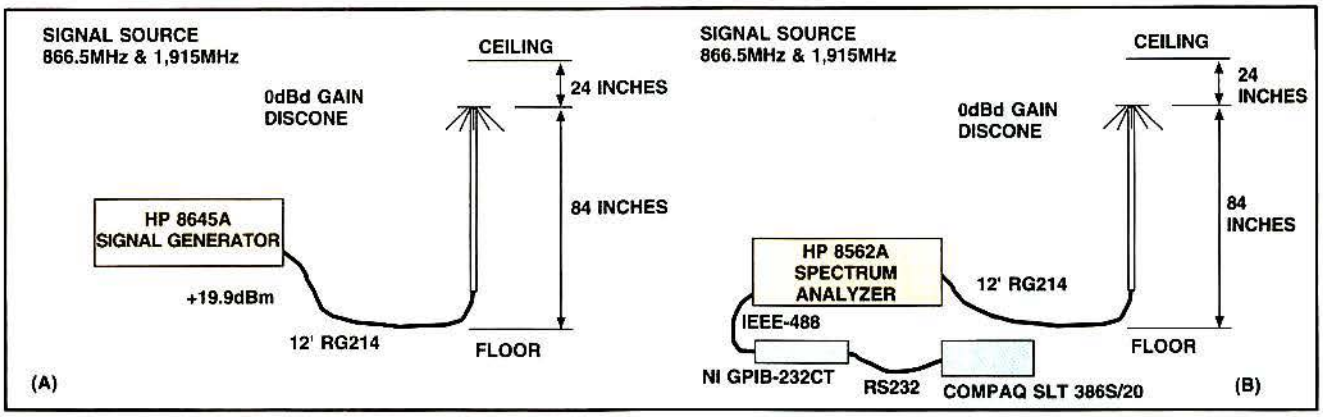



**Figure 2. The signal source (A) was an HP 8645A signal generator set to +19.9dBm output and connected to a broadband antenna 84 inches above the floor. The receiver (B) was an HP 8562A spectrum analyzer connected to a similar antenna. Samples of the received level at a rate of one sample per second were taken by a 386 computer connected to the spectrum analyzer over an IEEE-488 bus. The signal generator and the receiver remained stationary to ensure that any change in received signal level was due to external sources.**

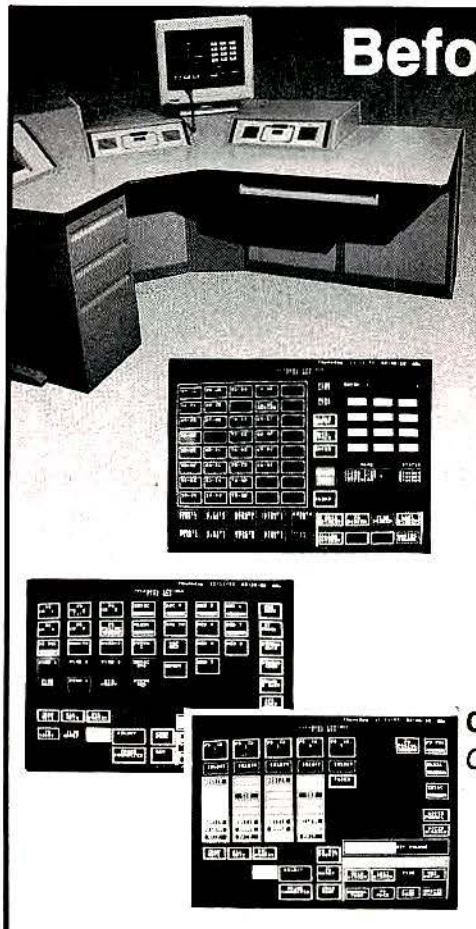
answer the question as to why hand-offs occurred when a user was stationary.

This phenomenon was not anticipated because it differs from experiences with cellular customers. A stationary user in cellular systems locks into a cell for as long as the user does not move. A hand-off occurs only when the user moves out of one cell coverage area into another. Clearly, this description does not apply to hand-offs indoors.

### In-building RF path loss

Several studies have been made to research RF propagation within buildings on proposed PCS frequencies. The initial tests were designed to measure RF path loss and multipath delay in an office building before any office furniture was installed. The next tests measured RF attenuation caused by office modular furniture and both concrete and sheet-rock walls at 915MHz and 1,915MHz. In this experiment, samples were taken at all accessible two-foot intervals on the eighth floor of the 1100 Peachtree St. building.

During the Campus PCS Office Trial, numerous hand-offs were made while the wireless telephone was motionless and, in many cases, while in clear view of cell sites.

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A variable that we had not considered was the effect of people and equipment moving about. Perhaps this movement could change propagation paths enough to cause hand-offs for a stationary user.

Additional tests on the eighth floor in the 1100 Peachtree St. building were made at 866.5MHz and 1,915MHz to observe path loss that may be caused by people in motion.

The first phase of the testing was performed with the signal source and the receiver placed at a line-of-sight distance of 38 feet. In the second phase, the receiver was placed 104 feet from the source; however, there was no line-of-sight path. Obstacles such as walls and office furniture were in the path. Testing was done at the frequencies of 866.5MHz and 1,915MHz.

An HP 8645A signal generator set to +19.9dBm output was connected to a broadband antenna 84 inches above the floor. (See Figure 2 on page 46.) The receiver was an HP 8562A spectrum analyzer connected to a similar discone antenna 84 inches above the floor. Samples of the received level at a rate of one sample per second were taken by a 386 computer connected to the spectrum analyzer over an IEEE-488 bus. The signal generator and the receiver remained stationary to ensure that any change in received signal level was due to external sources.

In 24 hours 86,400 received signal measurements were collected. The samples were reduced to 1,440 points by averaging sixty samples for each minute. The averages were used to plot the mean signal levels for the 24 hours. In addition, the difference between the highest and lowest samples during any minute was plotted to show the amount of signal deviation.

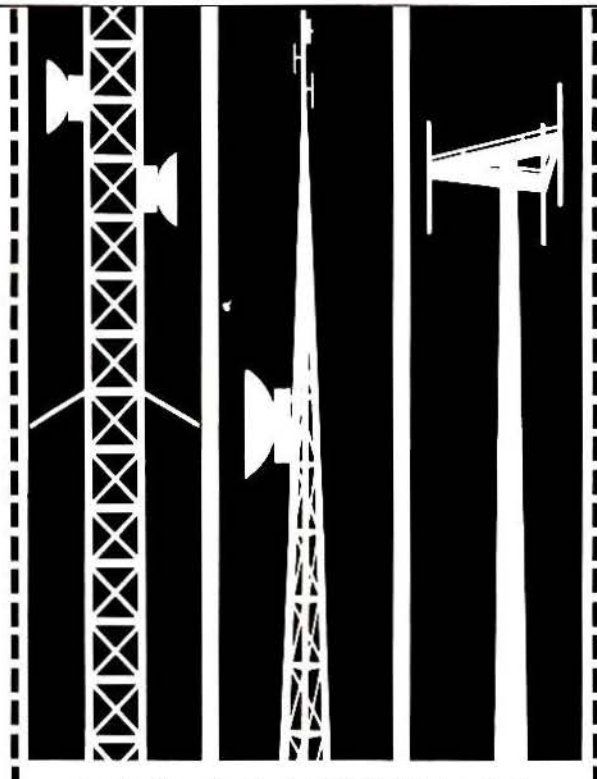
## Results

Figure 3 on page 50 shows measurements taken at 866.5MHz using a line-of-sight path distance of 38 feet. The horizontal axis indicates the time of day from 0000 to 2400 hours, and the vertical axis shows the measured signal level in dBm. Trace A represents the mean of one minute's worth of samples and shows fairly constant levels from 1900 to 0700 hours (7 p.m. to 7 a.m.).

On the other hand, when employees were on the floor from 0700 to 1900 hours (7 a.m. to 7 p.m.), the mean signal level varied from –43dBm to –37dBm, a 6dB swing. Trace B (with a vertical axis on the right) indicates the difference between the maximum and minimum levels in decibels recorded during each minute and shows a maximum deviation of 5dB.

Results of a blocked signal path are shown in Figure 4 on page 50. The point-to-point distance between the source and receiver was 104 feet, but several concrete walls and an elevator lobby blocked the direct signal path. This plot is configured similarly to the line-of-sight graph with Trace A being the mean and Trace B the difference between maximum and minimum signals. Because the direct path was blocked, the signal path was propagated via reflections down hallways and around the central core of the floor.

Because the propagation depended on reflections, the signal path was seriously disturbed when employees moved about on the floor. Minimum and maximum signal levels varied as much as 30dB. Changes of this magnitude were enough to cause a stationary user to hand-off. Therefore, these two figures show the effects of employee movement in the test area. Most employees are in the building between 8 a.m. and 6 p.m., although night watchmen roam the halls during the night. The results at 1,915MHz were almost identical

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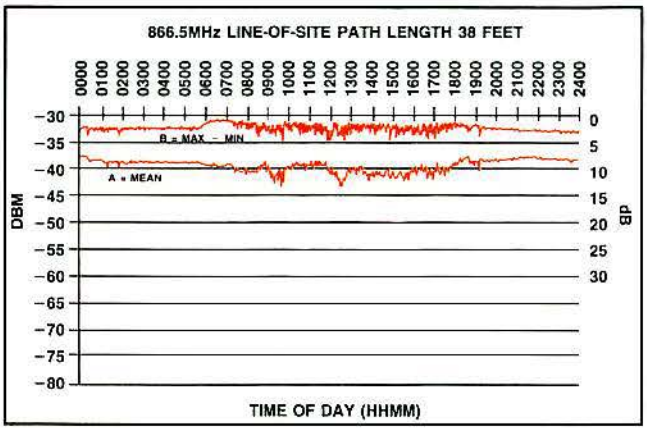



Figure 3. These are recorded signal measurements taken at 866.5MHz using a line-of-sight path distance of 38 feet. The horizontal axis indicates the time of day from 0000 to 2400 hours, and the vertical axis shows the measured signal level in dBm. Trace A represents the mean of one minute's worth of samples and shows fairly constant levels from 1900 to 0700 hours (7 p.m. to 7 a.m.). On the other hand, when employees were on the floor from 0700 to 1900 hours (7 a.m. to 7 p.m.), the mean signal level varied from −43dBm to −37dBm, a 6dB swing. Trace B (with a vertical axis on the right) indicates the difference between the maximum and minimum levels in decibels recorded during each minute and shows a maximum deviation of 5dB.

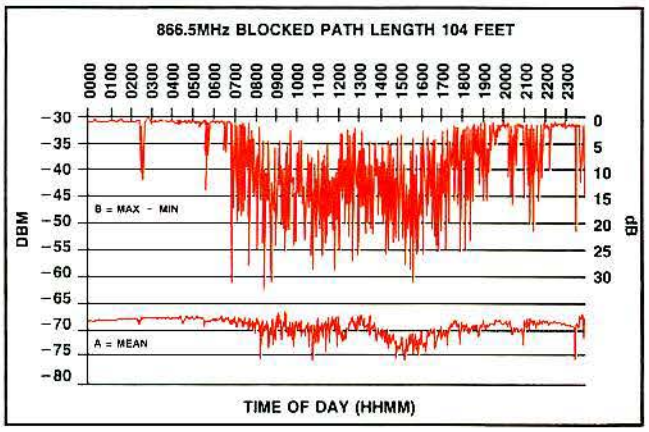



Figure 4. A reception was conducted with a blocked signal path where the point-to-point distance between the source and receiver was 104 feet and where several concrete walls and an elevator lobby blocked the direct signal path. This plot is configured similarly to the line-of-sight graph (Figure 3) with Trace A being the mean and Trace B being the difference between maximum and minimum signals. Because the direct path was blocked, the signal path was propagated via reflections down hallways and around the central core of the floor.

to those at 866.5MHz.

## Conclusions

The indoor RF environment is highly volatile. Signal levels and RF paths constantly change as a result of the random movements of people and machinery such as elevators and automated mail delivery equipment. This volatility can be further aggravated where RF loss through a floor is low. Given a line-of-sight path of 38 feet between a signal source and the receiver, the signal may change by as much as 5dB. Along a blocked path of 104 feet, the signal deviation can be as much as 30dB. The effects that people in motion have upon signal propagation seem to be nearly the same on 866.5MHz and 1,915MHz.

Future personal communications services must be equipped with handoff algorithms to compensate for rapid fades caused by people moving within the building. RF floor penetration differences will require the attention of the equipment manufacturer and the service provider that designs the specific system.

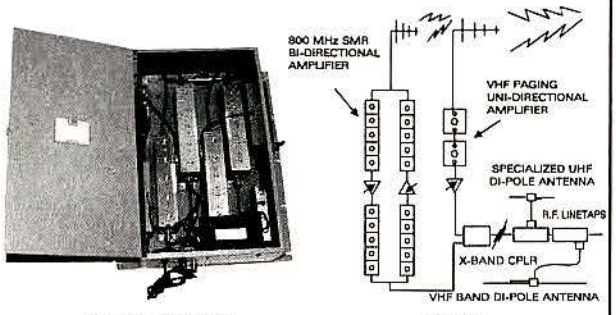
First, the equipment manufacturer will need to optimize hand-off algorithms to respond to the rapid signal changes caused by volatile indoor multipath stemming from people in motion and the particular dimensions of some indoor areas. The algorithm will need to monitor sudden reductions in RF signal level *and* audio quality to trigger a handoff only when quality is about to degrade to an unacceptable level. (The system vendor of our trial equipment developed and installed an algorithm that resolves both problems).

Second, the system provider will need to be aware of the RF penetration in a given building. This information will be used when estimating the amount of equipment required to provide ubiquitous coverage.


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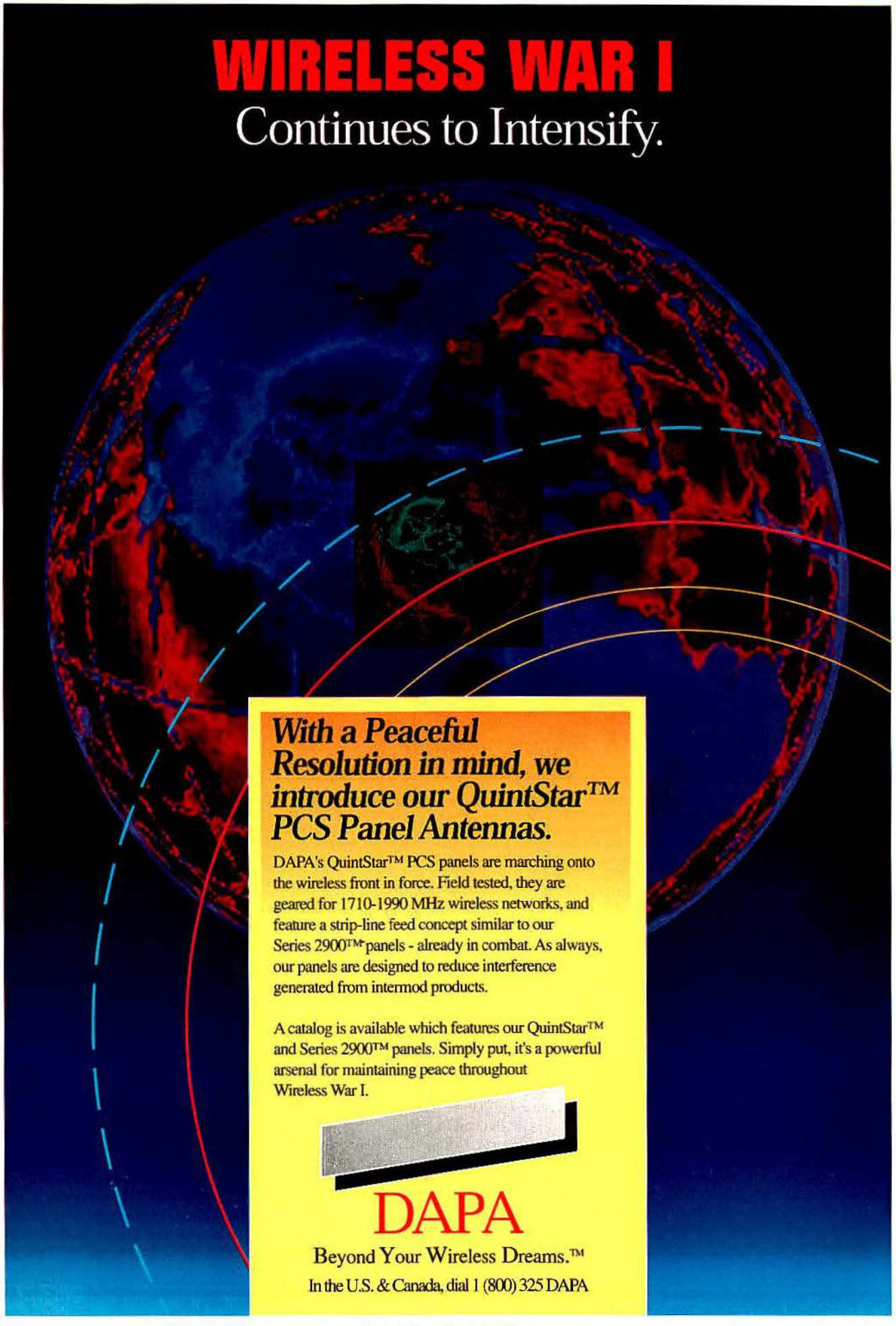
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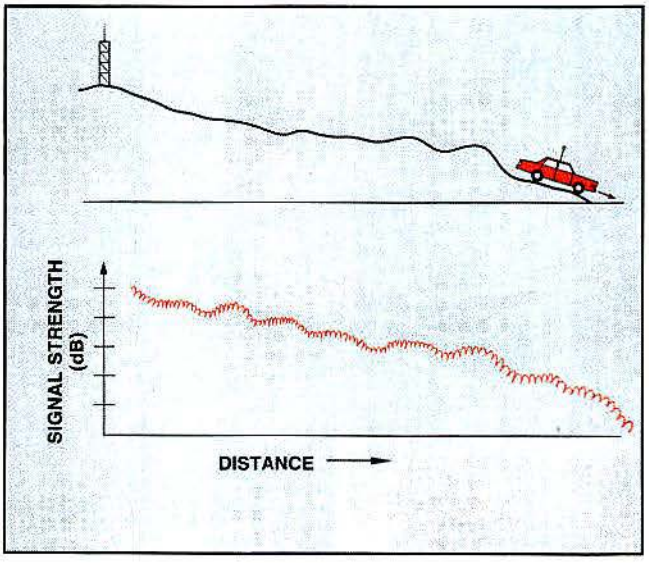



**Figure 1. Long-term fading is caused primarily by distance and terrain. In general, as the distance between transmitter and receiver increases, the signal amplitude tends to decrease. Received signal levels tend to be stronger when the mobile receiver is on hilltops with a line-of-sight radio path to the transmitter. Signals are weaker when the line-of-sight path is blocked by terrain.**

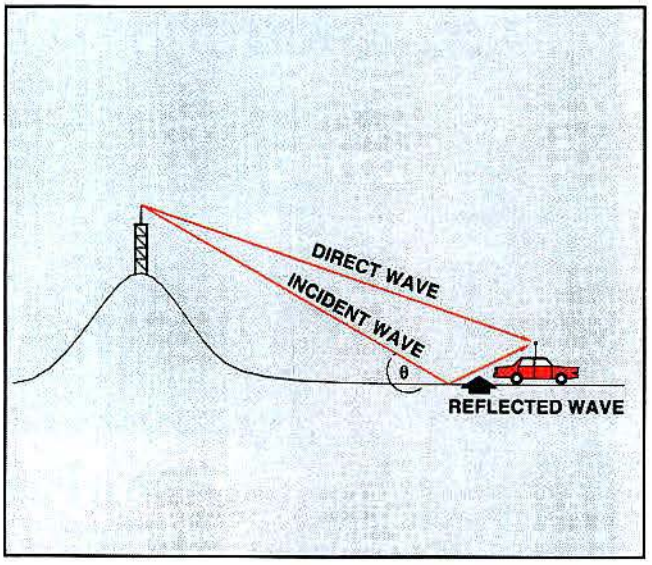



**Figure 2. Short-term (multipath) fading is caused by a physical characteristic of electromagnetic waves. A direct wave travels from the transmit antenna to the mobile receiver antenna. In addition, an incident wave strikes the ground close to the vehicle and reflects upward and into the receiver antenna.**

**By Shane Fitzgerald**

The best criterion for evaluating radio system performance is the mobile user's ability to communicate successfully, defined as meeting or exceeding a standard of performance.

A radio receiver's ability to meet a performance standard is a function of the received signal strength. If the received signal is at or greater than the level required, successful communication is possible. If the received signal is less than the required level, successful communication is not possible.

Short of equipment failure, there is only one reason for the received signal amplitude to fall below the required level: *fading*. Fading is unquestionably the greatest cause of failed mobile radio communications. Reducing the effects of fading leads to significant improvements in radio system performance.

Two types of fading are present in the mobile radio environment, long-term fading and short-term fading.

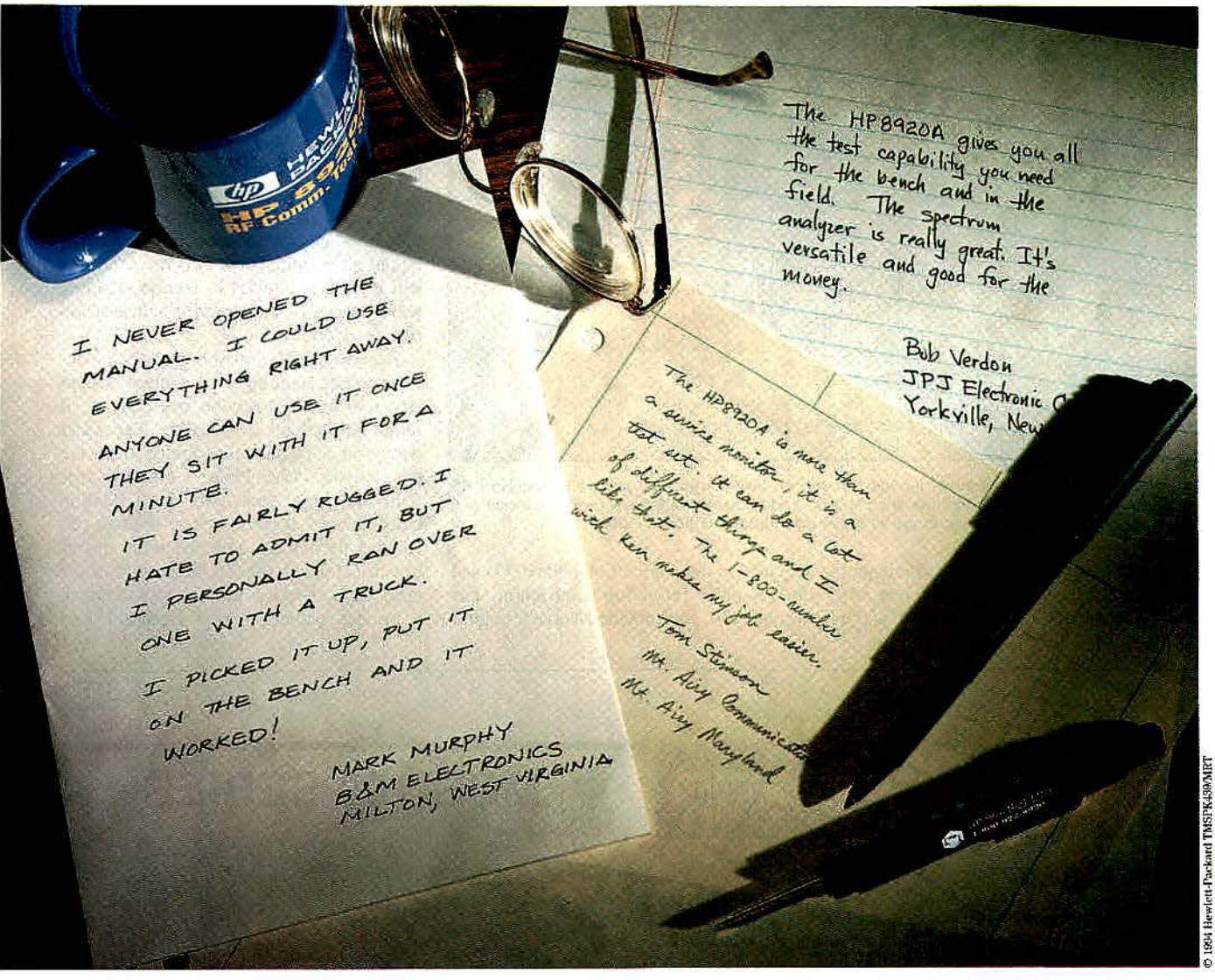
Long-term fading is caused primarily by distance and terrain. In general, as the distance between transmitter and receiver increases, the signal amplitude tends to decrease. Received signal levels tend to be stronger when the mobile receiver is on hilltops with a line-of-sight radio path to the transmitter. Signals are weaker when the line-of-sight path is blocked by terrain. (See Figure 1 above left.)

Long-term fading has a gradual effect. As a receiver moves through a radio system's coverage area, the signal amplitude gradually moves up and down in response to distance and topography. The effects of long-term fading cannot be corrected at the mobile unit. Coverage deficiencies induced by long-term fading can be corrected only by changing the number or location of the radio sites, or by using on-frequency-repeater technology.

Short-term (multipath) fading is caused by a physical characteristic of electromagnetic waves. (See Figure 2 above right.) A direct wave travels from the transmit antenna to the mobile receiver antenna. In addition, an incident wave

Fitzgerald is RF design engineer at ElectroCom Communications Systems, Santa Fe Springs, CA. ElectroCom manufactures the ideal selection diversity controller described in this two-part article.

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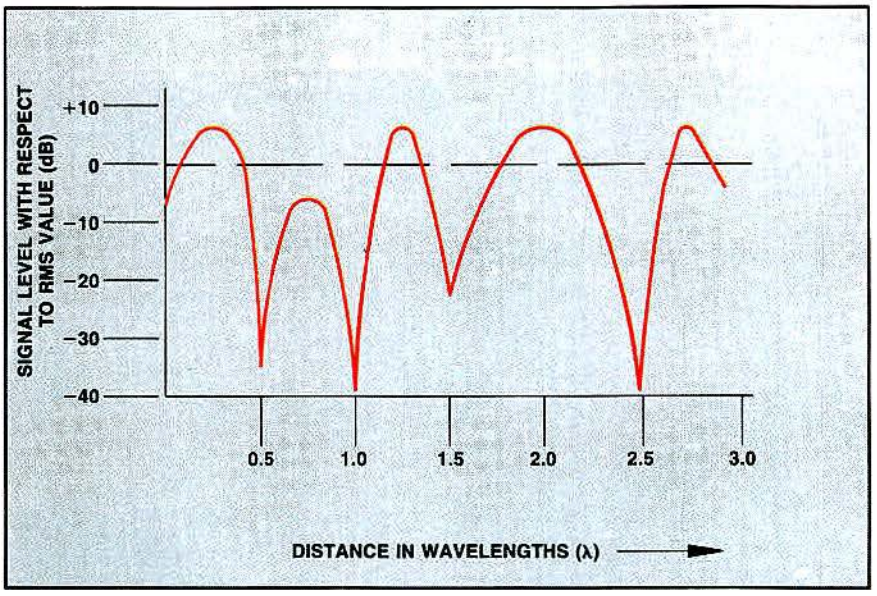



**Figure 3. When a mobile receiver moves through an area, large fluctuations in received RF amplitude result. These fluctuations are periodic and occur at half-wavelength intervals (6.9 inches at 850MHz). The dynamic range of these fluctuations is about 50dB.**

strikes the ground close to the vehicle and reflects upward and into the receiver antenna. The power in the reflected wave depends on the angle of incidence ($\Theta$) and the ground's reflection coefficient. For average soil, the reflected wave's magnitude exceeds 0.9 when $\Theta$ is less than 10° (which almost always is the case in land mobile communications). This small difference in magnitude means that the reflected wave's amplitude will be similar to the direct wave's amplitude. The mobile receiver responds to two sources of radio energy, the direct wave from a distance and the reflected wave from the ground in close proximity to the receiver.

When an electromagnetic wave strikes a reflector, its phase shifts 180°, a phenomenon known as specular or mirror-image reflection. These two waves, direct and reflected, interact to form a standing wave pattern of *constructive* and *destructive* interference.

Because it is impossible to *see* an electromagnetic standing wave pattern of constructive and destructive interference, it might be difficult to visualize. The water waves in a ripple tank demonstrate the phenomenon. (See Photo 1 on page 56).

In the ripple tank, two small floating balls (located at the center of the two circular patterns) are attached with strings to vertical oscillators on the bottom of the tank. As each ball oscillates up and down, it creates waves. Waves from the two

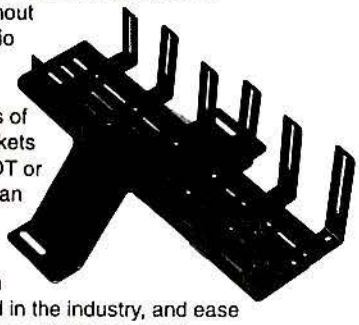
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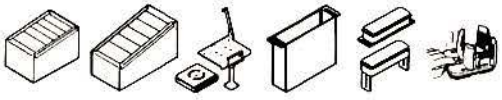
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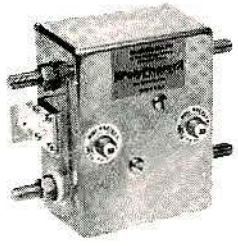
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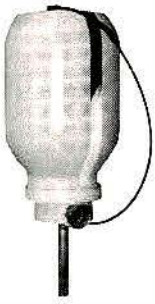
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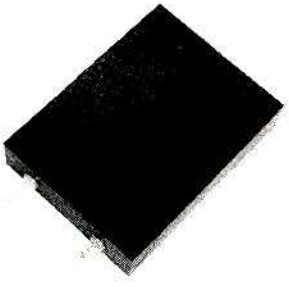
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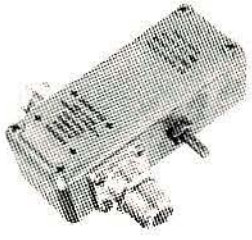
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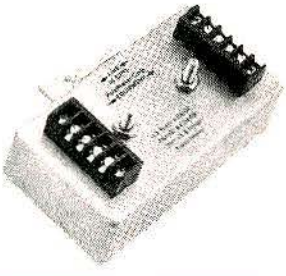
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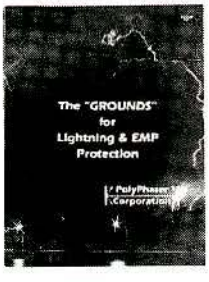
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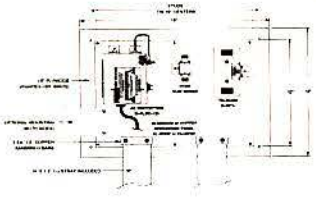
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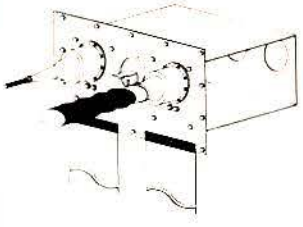

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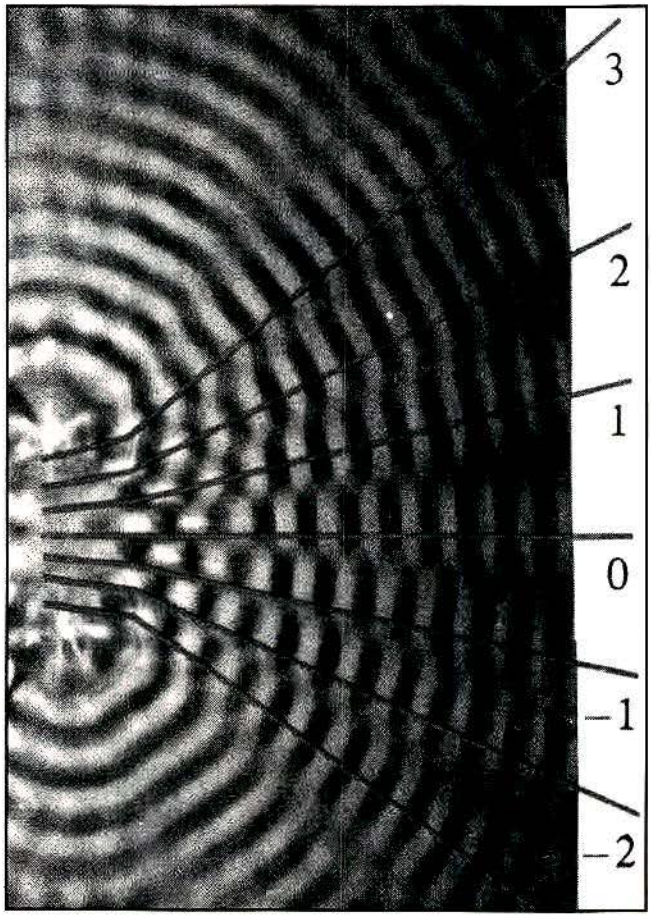



Photo 1. Because it is impossible to *see* an electromagnetic standing wave pattern of constructive and destructive interference, it might be difficult to visualize. The water waves in a ripple tank demonstrate the phenomenon.

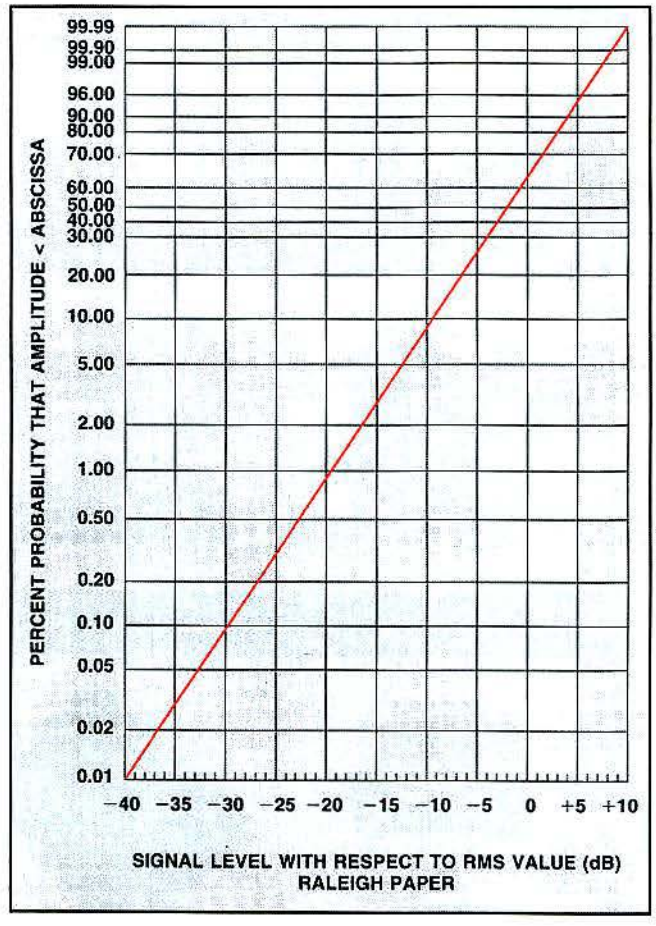



Figure 4. Signal amplitude at any given point ranges from 10dB above the average value to 40dB below the average value. This distribution is presented in its most useful form—Rayleigh paper.

sources react with each other to form the standing wave pattern visible in Photo 1.

This two-source interference pattern resembles the direct and reflected radio-frequency (RF) standing-wave pattern created by two sources of radio energy. Clearly visible in the photo are the lighter shades of the crests and the darker shades of the troughs of the standing-wave pattern.

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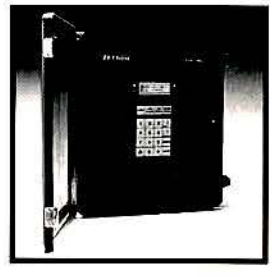
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The distance from maximum to minimum amplitude of the standing-wave pattern is one-half wavelength of the frequency of oscillation of the floating balls. Similarly, the distance from crest to crest or from trough to trough of short-term mobile radio fading is one-half wavelength of the radio waves' oscillation.

When a mobile receiver moves through an area, large fluctuations in received RF amplitude result. These fluctuations are periodic and occur at half-wavelength intervals (6.9 inches at 850MHz). The dynamic range of these fluctuations is about 50dB. Figure 3 on page 54 illustrates amplitude variations that a moving vehicle typically might encounter.

The distribution of short-term fading is a function of two random variables and is the sum of coherent sinusoidal waves of random phase and random amplitude. This sum describes exactly the mobile radio short-term fading phenomenon, which sometimes is referred to as *Rayleigh fading* after Lord John William Strutt Rayleigh (1842–1919), a British physicist who first described the distribution.

Signal amplitude at any given point ranges from 10dB above the average value to 40dB below the average value. This distribution is presented in its most useful form—Rayleigh paper—in Figure 4 on page 56.

Rayleigh paper is an extremely useful tool for determining the percentage of probability that a signal will be above or below the average value. Numbers across the bottom of the graph represent signal amplitude (with respect to the average value) in decibels; therefore, 0 is the average value.

To find the percentage of probability of encountering a fade 20dB less than the average, follow the vertical –20dB line upward until it intersects with the diagonal line. Then read the graph directly to the left. In this example, there is a 1.0% probability of encountering a fade of 20dB.

Fade margin is an RF system design characteristic that indicates the system's ability to tolerate fades. It is expressed in decibels above the threshold where reliable communication takes place. As long as the average RF signal amplitude is 40dB above the level necessary for reliable communications—a figure that represents a 40dB *fade margin*—short-term fading will have no noticeable effect on the ability to communicate. Unfortunately, maintaining a 40dB fade margin in the field is practically impossible.

When a given geographic area's fade margin is 20dB, 1% of the locations within the area will have RF amplitude below what is required for communication. If the fade margin is 10dB, then 10% of the locations will have RF amplitudes below that required for communications.

For voice communication via radio, fade margin can be translated directly into system reliability because short-term fading effects on voice communication are more of a nuisance than a serious problem. The mind's processing power enables a listener to understand a voice message despite occasional noisy pops and hisses.

Short-term fading is extremely destructive to high-speed data communications. What the ear would endure as one little pop or a hissing sound may destroy several hundred bits of information. A mobile unit traveling at 15mph through a stationary environment will encounter 38 fades per second, and more if the environment includes moving objects such as trains, aircraft and automobiles. If these fades sink below the receiver's data recovery threshold, successful data reception becomes nearly impossible.

*Next: How the integrity of data communications can be protected in a fading environment.*


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(continued from page 8)

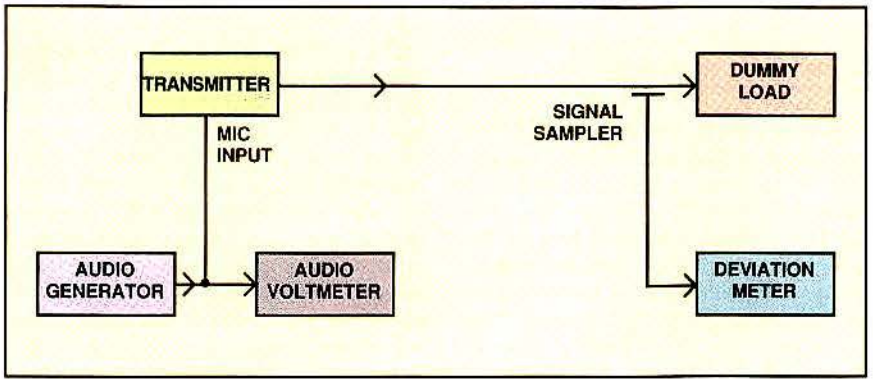



**Figure 2. This is the equipment configuration used to measure modulation sensitivity. This procedure is to be followed when running performance checks on the transmitter as described in the text.**

ing circuit provides for special characteristics that permit repeatable measurements on speech signals. The modulation density meter's scale is calibrated from 0 to 10 density units (DU). A modulation density of about 5DU would be considered good. Excessively clipped signals would register on the high end of the scale, and under-clipped signals would read on the low end. So, the target is five or six density units with speech modulation.

### Measurement instrument

The instrument used to measure modulation density is available as a standard feature of the Helper Instruments model SM-1000 service monitor. (See Photo 1 on page 8.) A new option of the SM-1000 is the TEK Meter by Tektronix, Beaverton, OR, which combines oscilloscope and digital multimeter (DMM) features for a powerful troubleshooting tool in itself.

### Modulation sensitivity

While on the subject, I would be remiss without mentioning the test procedure for modulation sensitivity. This procedure always should be used when running performance checks on the transmitter.

The specification for modulation sensitivity is printed in all good service manuals for radio communication transceivers. The setup for the procedure is shown in Figure 2 above. The procedure is as follows.

(1) Set the audio generator to 1,000Hz. With the transmitter keyed, increase the audio generator level until the modulated signal is well into clipping.

(2) Set the peak deviation control for rated system deviation (+5kHz).

(3) Reduce the level of the audio generator until the deviation meter reads 60% rated system deviation (+3kHz).

(4) The modulation sensitivity is then read as the voltage on the audio voltmeter.

Typical modulation sensitivity specification figures are 100mV, give or take a few decibels. Poor modulation sensitivity indicates lack of gain somewhere in the transmitter speech circuitry ahead of the clipper. A transmitter with poor modulation sensitivity still can produce rated peak deviation with a fully clipped signal. However, the modulation density of such a transmitter will be poor.

Incidentally, most technicians do not set the peak deviation to the full +5kHz. Usually, it is set to about +4.5kHz—especially when continuous tone-controlled squelch system (CTCSS) tones are used.

The point is this: If you simply check for peak deviation with constant-tone modulation, you are not getting the whole picture. Check the modulation with real speech signals. The best way to check modulation with speech signals is with the modulation density meter.

### Standardization

This brings up a point. Why is there no standard for modulation density or some equivalent unit for setting the audio levels in a transmission system for proper speech modulation? A similar standard for *volume units* (VU) was developed years ago for setting of speech and music program levels on wire lines properly using a VU meter.

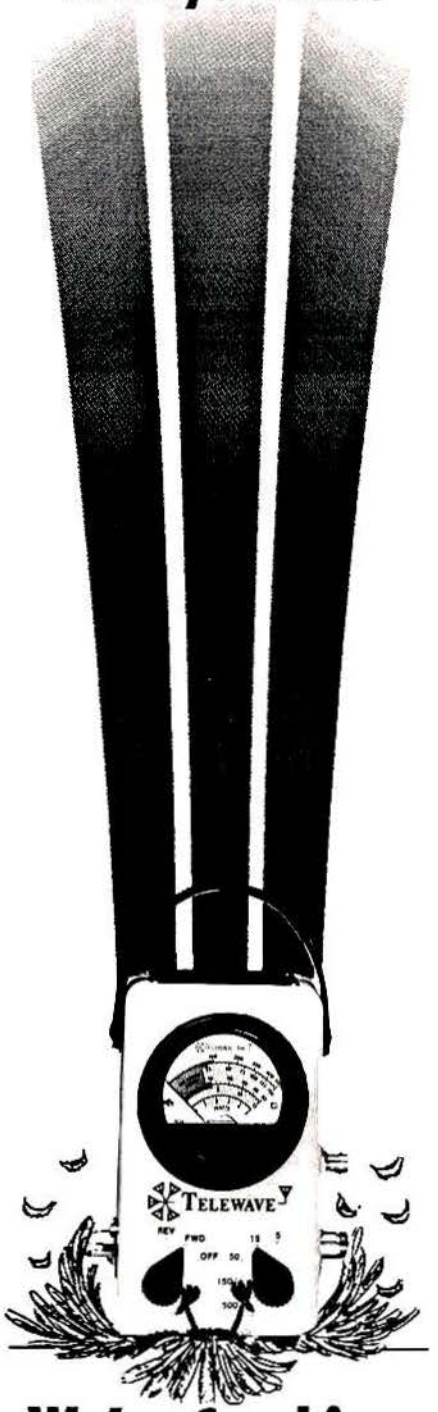
Bill Detwiler's work certainly should be considered in the development of a standard for such measurements for land mobile radio. Maybe the DU should be called *Detwiler unit* instead of *density unit!* Maybe engineers who develop and set standards will provide some input.

Until next time, *stay tuned!*




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# A backlog of applications and ideas

By Robert H. Schwaninger Jr.

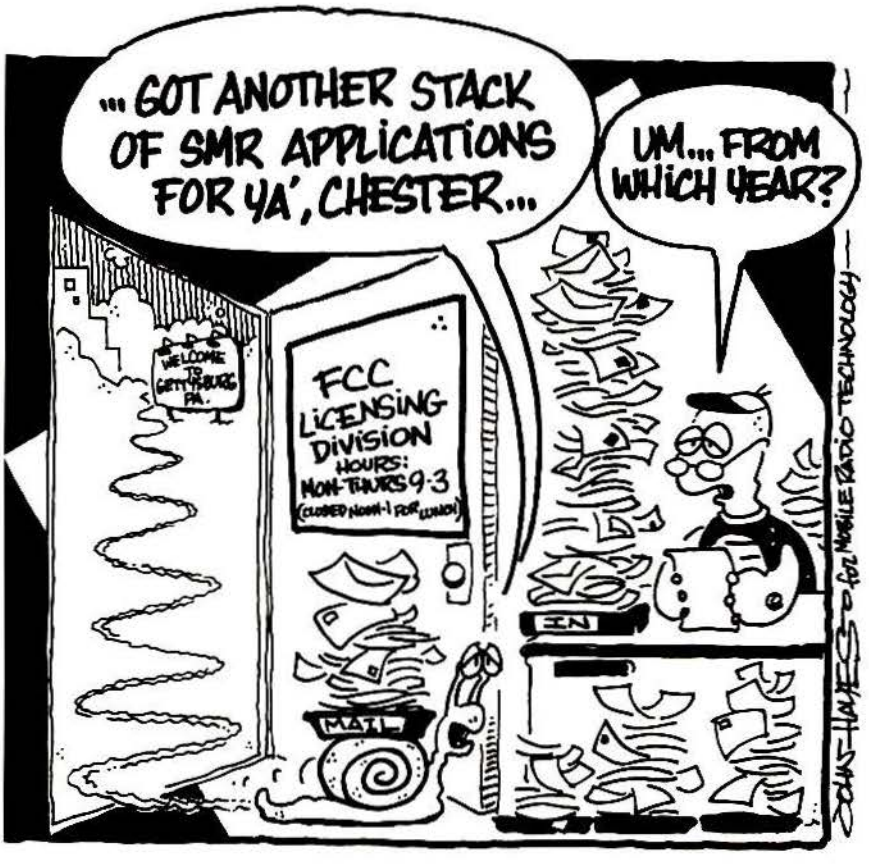
There is a backlog of more than 40,000 specialized mobile radio (SMR) applications sitting, neatly stacked, at the FCC's Licensing Division in Gettysburg, PA. The FCC's latest "Speed of Service Report" indicates that an average application for 800/900MHz band trunked facilities will take 398 days to process. Other applications for 800/900MHz band licenses, including paging, will take about 175 days to process.

Since the creation of this backlog, and during its geometric rise from annoying to critical proportions, questions have been asked throughout the industry as to the cause of the collapse of application processing. Why did the problem occur? Why has it not been alleviated? What can radio systems operators do about licensing for the duration of the problem?

Schwaninger, *MRT's* regulatory consultant, is a partner in the law firm of Brown and Schwaninger, Washington, DC. He is a member of the Radio Club of America.

The FCC has long complained that it lacks adequate resources to do its job. Given this time-honored excuse for slow service, one must first explore whether the problem *is* simply money. It could be that the FCC's staff was simply overwhelmed with enhanced SMR (ESMR) applications, speculator applications, assignment applications arising from consolidations among system operators and other applications that reflect this overheated portion of the telecommunications marketplace. In fact, as many as half of the applications held in the backlog may be the work of applications mills and other independent speculators.

Yet, the "inadequate resources" excuse falls apart in view of the evidence. The FCC lists Nov. 8, 1993, as the processing date for *all* "wait list" applications, regardless of region. This means all applications entered up to and including Nov. 7, 1993, have been processed. If the problem *were* simply money, the processing of applications would not be equal across regions. Regional processing teams work at their own pace, with California applications, for example, usually lagging behind.



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The fact that the earliest applications pending for each region were entered on Nov. 8, 1993, means that a policy decision must, in part, be responsible for the backlog.

The FCC apparently has been anticipating rule changes that might affect the way the applications are processed. The backlog was created to suspend processing during the rulemaking. It is curious that this suspension of processing services was accomplished without the benefit of public statement, rulemaking or public comment.

The FCC's intentions can be deduced from its rulemaking proceedings that affect the nature of SMR licensing. It is evident that the commission has some interest in using auctions to assign 800/900MHz band licenses. If the FCC were to process the pending applications under the rules in effect when they were filed, the agency would be "giving away" inventory that otherwise might be sold later to the highest bidder.

The pending applications reflect a *non-regional* approach to SMR licensing, without regard to Rand-McNally-defined "Major Trading Areas (MTAs) or "Basic Trading Areas" (BTAs) or any other market-coverage-based approach to licensing. Instead, the 40,000 applications are for systems designed to fill in the radio coverage for areas not blocked by existing facilities, regardless of where the Rand-McNally map-makers might believe contiguous markets to exist.

*It is evident that the commission has some interest in using auctions to assign 800/900MHz band licenses.*

If the FCC were to use its proposed auction and market-based licensing for SMR systems, it would save money because issuing blanket market-based licenses greatly reduces administrative costs. Moreover, the agency would receive a small amount of money as auction proceeds. The FCC also may eliminate its burden of wait-list management and much of its loading count oversight responsibility. It may practically eliminate the effect of applications mills, too. In sum, it would reduce its burden in regulating the spectrum, an achievement that says, in effect, that *administrative efficiency equals public interest.*

What is lost in the FCC's "equation" is harm caused to the public through the suspension of the application-processing procedures, which results in spectrum not being used to serve the public. Through its effort to save administrative costs and to make auction dollars, the FCC has denied necessary spectrum to operators that legitimately want to use the channels to serve the public.

Beneath all of the agency's machinations lurks the effect that the backlog has had on larger ESMR operators vs. smaller operators. Interpreting in a strange way its recent order imposing a moratorium ("freezing") on the acceptance of SMR applications, the FCC has declared that the freeze does not apply to *applications supported by waiver*, i.e. applications for *wide-area system licenses*. The FCC's efforts are calculated to favor larger ESMR operators over smaller analog operators.


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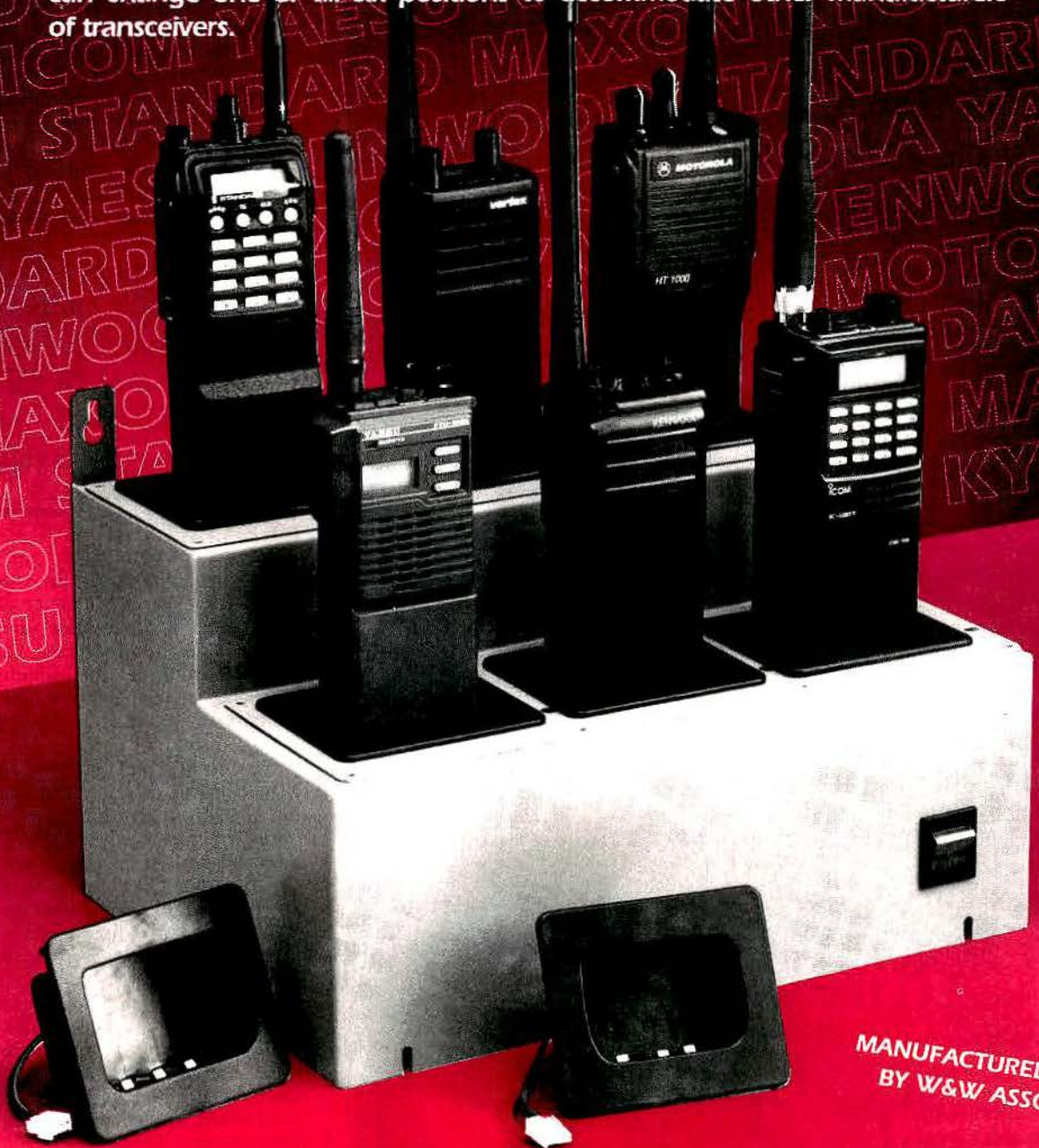
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Indeed, even the backlog itself favors larger operators, the same ones that might benefit from auctions and market-based licensing. Therefore, if the true motive for halting location-based license application processing is to set the stage for auctions and MTA license applications, the FCC clearly is favoring the largest operators. Add to this mix the notion entertained by the FCC that it might approve forcing analog SMR operators to migrate from frequencies coveted by ESMR operators, and the trend is painfully clear.

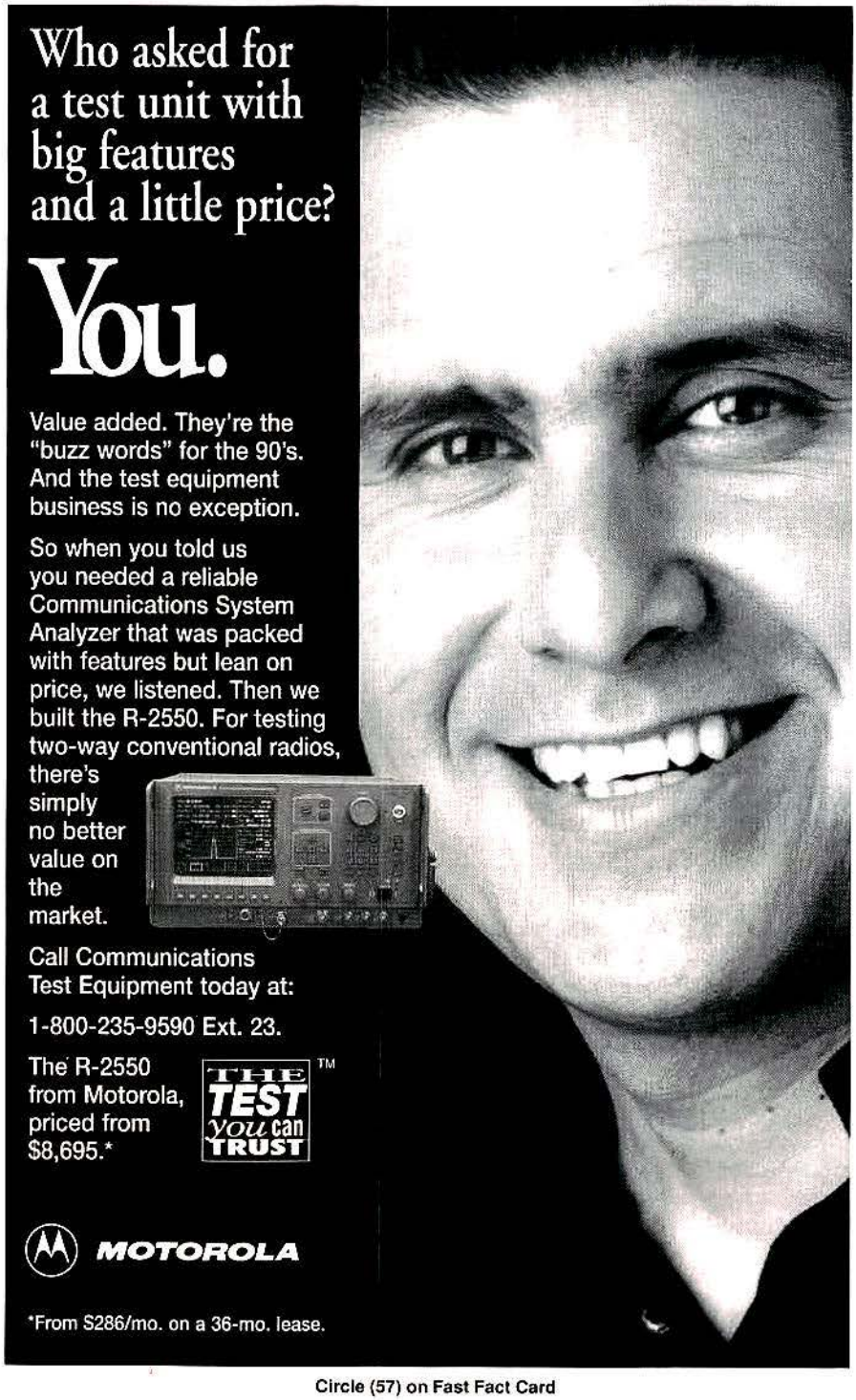
It has been difficult to advise analog SMR system operators during this time. Their applications either are held in the backlog or are frozen out of the FCC's processing altogether. The FCC's actions are calculated to harm the analog SMR industry while favoring the agency itself and only the largest system operators. Meanwhile, the agency is silent as to its true motives, leaving the industry to guess and to speculate each time a business decision must be made or an investment must be considered.

This situation indicates the FCC's continued blind adherence to the axiom that "What is good for the FCC is good for the public." What the FCC seems to forget is that the public is best served by a free and open marketplace, where the small may become larger through improved service, spectrum opportunities, competitive pricing and specialized knowledge of the market. Such a marketplace cannot be constructed using a centralized approach that favors administrative efficiency over service, consolidation over decentralization and networks over hard work.

This industry has been long served by the entrepreneurial spirit of the thousands of operators across the country that deliver services to the majority of the public. The FCC's actions chill the independent spirit of these same operators without benefiting the nation except for saving a little administrative time and making a paltry sum in auction dollars. The return is too small for such a large price.

*This situation indicates the FCC's continued blind adherence to the axiom that 'What is good for the FCC is good for the public.'*

The small analog SMR operators should fight, and fight hard, to preserve their rightful position in the market. This is no time to give up. The FCC must be made to recognize that the industry is not merely a small collection of billion-dollar conglomerates, but a chorus of individual, hard-working, telecommunications professionals who are entitled to keep the fruits of their labor, without undue government interference or favoritism. If the largest ESMR operators do not approve, politely remind them that they chose to compete in a mature market with an established playing field, and that fairness requires that the rules be the same for all.



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### Allegations of perjury lodged against Nextel

In pleadings filed with the FCC on Sept. 16, 1994, Edwin Fowlkes, a finder who has targeted an SMR license held by Nextel, Rutherford, NJ, alleged that Nextel's regulatory counsel, Joel Margolis, committed perjury before the FCC and attempted to suborn perjury from a tower operator, L. Joseph Clinton, president of Clinton Tower Service.

According to the documents filed before the FCC, Fowlkes claims that Joel Margolis attempted to get Clinton to change his earlier testimony in support of Fowlkes' finder's preference request, to state that the subject station was constructed. Then, when Clinton repeatedly refused to cooperate with Margolis and Nextel, Margolis went before the FCC and claimed that construction had occurred, the document reads.

Fowlkes' allegation of perjury is supported by two affidavits signed by Clinton, who also claims that Margolis and other Nextel employees have conspired to commit perjury and to get Clinton to join the conspiracy.

Fowlkes' petition asks for a favorable ruling on his finder's preference, prosecution of Margolis and a commission investigation into whether Nextel possesses the character qualifications to be a commission licensee.

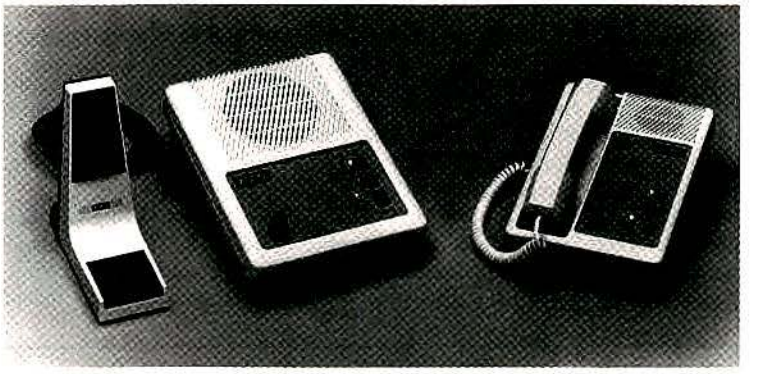
### Motorola donates radio equipment to university electronics program

Motorola's Land Mobile Products Sector, Schaumburg, IL, donated seven radio base stations to the Southern Illinois University at Carbondale Electronics Technology Program in its College of Technical Careers. The base stations will be used to train students about the design, features, electronic components and servicing of increasingly sophisticated radio communications systems.

### Trilogy selects Electronic Products as manufacturer's rep

Trilogy Communications, Jackson, MS, has selected Electronic Products, Hartland, WI, as its exclusive manufacturer's representative for Illinois, Wisconsin, Michigan and Indiana. Trilogy is entering the wireless communications market with 50Ω Air-Cell low-loss transmission line in the popular sizes. Typical applications will include base station, cellular site and PCS fixed installations.


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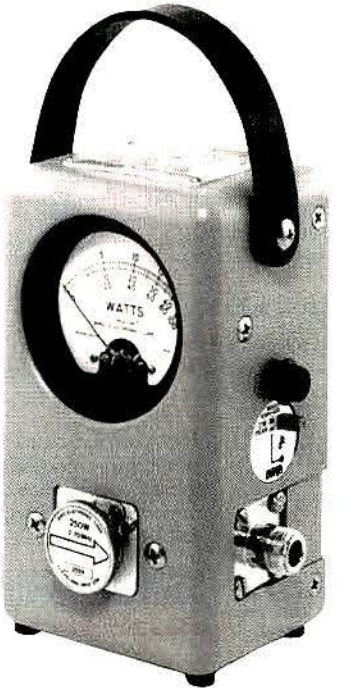
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## Modular Communications completes installations for forestry service

Modular Communications Systems (Moducom), North Hollywood, CA, has completed installation of Ultra-Com Pro communications consoles for the Modoc National Forest Service, Alturas, CA, and the Mendicino National Forest, Willows, CA. The five-position Modoc system and the four-position Mendicino system feature the Ultra-Com Pro with touchscreen displays. The proprietary Screenmaker and Customizer programs allow the user to design screens and operating parameters for specific systems and procedures.

The console is 486-based, supported by Intel's 16-bit 8097 microcontroller. Independent microcontrollers make it possible for workstations to operate independently.




Circle (60) on Fast Fact Card


## E.F. Johnson wins two orders for 220MHz equipment

E.F. Johnson, Burnsville, MN, has received a $1.9 million equipment order from Tribell Communications, Carson City, NV, and MacMillan Communications, Davie, FL, for the joint venture development of a multi-state, narrowband radio communications system using the 220MHz-222MHz frequency band.

Tribell and MacMillan plan to develop a spectrum-efficient network that will allow mobile radio dispatch operators to maintain communications with fleet users traveling from southern Florida to western Texas. The Tribell/MacMillan group has 100 channels under construction in Texas, and plans to construct 75 channels in Florida.

The joint venture will do business in Indiana, Pennsylvania, Nevada, Arizona, Utah and California, and the group says it plans further expansion in 1995 when additional licenses become available.

E.F. Johnson received an order from Pagers Plus Cellular, Walnut Creek, CA, for 220MHz radio systems equipment infrastructure to be used in the development of 82 narrowband systems nationwide. The systems will be used mainly for dispatch service similar to that of specialized mobile radio (SMR) operators, and some systems will provide telephone interconnect capability for end users. Pagers Plus will build systems at 65 locations in 20 states, the first in Dayton, OH.

## Glenayre chooses Trimble's GPS technology for paging network

Trimble Navigation, Sunnyvale, CA, has been awarded a $2 million contract to provide Global Positioning System (GPS) timing technology to Glenayre Technologies, Charlotte, NC. Trimble's antennas and receivers will be integrated with Glenayre's paging and wireless communications network equipment to provide precise synchronization of RF simulcasts used in digital paging services.

The agreement is Trimble's largest to date to supply GPS technology for use in wireless paging and communications networks. During the next two years, Glenayre will install several thousand custom Trimble AcutimeII GPS modules on transmitter controller towers in its GPS-C2000 network control system. the AcutimeII modules will synchronize Glenayre's transmitter controllers using GPS technology, allowing paging networks to operate more efficiently.

### ElectroCom wins Wisconsin communications system contract

ElectroCom Communication Systems, Santa Fe Springs, CA, has won a contract for phase 1 of a statewide mobile data communications system (MDCS) in Wisconsin. The Wisconsin State Patrol and the Wisconsin Department of Transportation have begun implementation of a six-site radio network. The system will use ElectroCom's newly developed diversity reception controller, a device designed to reduce the destructive effects of multipath fading, resulting in improved radio signal reliability and coverage.

The six radio sites included in phase 1 are expected to provide coverage of more than 5,000 square miles. Additional sites will be added under the provisions of the multi-year contract with ElectroCom as needs and funds dictate.

### Selectone makes new appointments

Selectone, Hayward, CA, has appointed Graham Radio, Reading, MA, as a distributor for the New England area. Graham Radio has been a distributor of communications accessories in the New England states for the last 30 years. Selectone has appointed EME IV, Williamsburg, VA, as its manufacturer's representative for Virginia. EME IV is a family-owned business that was founded in 1980.

### Simmonds Communications to acquire Intelatech

Simmonds Communications (SCL), Toronto, Ontario, Canada, has entered into a letter of intent to acquire all of the outstanding shares of Intelatech, Mississauga, Ontario, Canada, for $2 million plus an earn out to be based upon the future profit performance of the company.

The initial payment will be satisfied through the issue of common shares of SCL. The completion of the transaction is subject to due diligence investigation, regulatory approval, final negotiation and legal documentation and the approval of the Board of Directors of the companies involved.

Intelatech is a manufacturer's technical stocking representative for both semiconductors and passive electronic components.

### PolyPhaser celebrates 15 years

PolyPhaser, Minden, NV, celebrated 15 years in business Oct. 1, 1994. From its start in a Florida garage, the company has progressed to a 53,000 square-foot manufacturing plant in Nevada. More than 2,500 products are available, as well as lightning protection books, videos and on-site consulting services.

### Positive Communications brings MessageWatch to mass market

Retailers carrying products from Positive Communications, Pleasanton, CA, will be the first in Los Angeles and New York to receive the Seiko MessageWatch. The product looks like a standard wristwatch but contains a miniature FM radio data chip capable of receiving a variety of information services, such as paging messages, voice mail notifications, weather forecasts, Dow Jones closings, local sports scores and daily lottery numbers. As a timepiece, the MessageWatch self-adjusts at least 36 times per day to the U.S. Bureau of Standards' atomic clock.

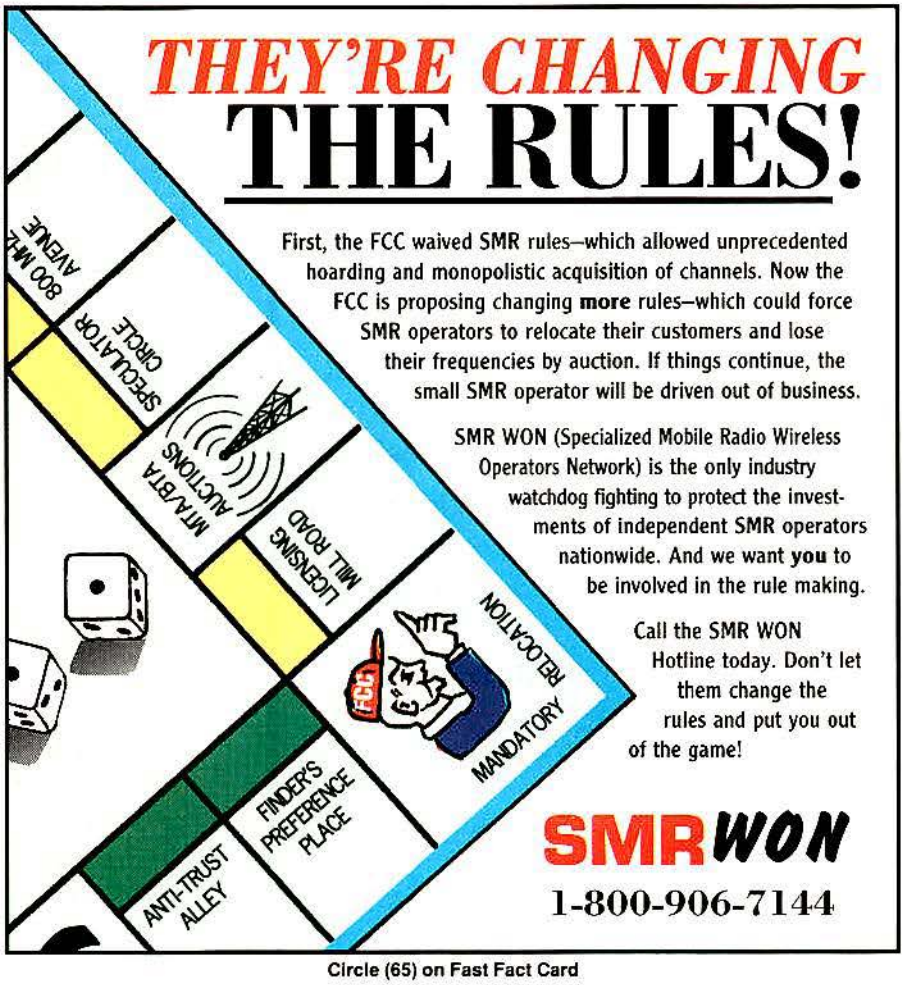
Positive Communications will begin selling the MessageWatch in Los Angeles and New York in October, and it is expected to be available in the top 20 U.S. metropolitan markets by the end of 1995.

### Everon Mobilcom, Everon America announce joint venture

Everon America, Jackson, MS, and Everon Mobilcom, Seoul, Korea, have formed a joint venture to manufacture and sell Everon products in the western hemisphere. Everon Mobilecom will continue to market and sell Everon products in the Asian and European markets using its offices in Seoul, Hong Kong and Beijing. Everon America will market and sell Everon products to the United States, Canada and Latin America.

### Thomas Wheeler to speak at WIWC breakfast meeting

Women in Wireless Communications (WIWC) will hold its first meeting of 1995 in conjunction with Cellular Telecommunications Industry Association's (CTIA) Wireless '95 in New Orleans. Keynote speaker Thomas Wheeler, president of CTIA, will address the group. The meeting will take place Thursday, Feb. 2 at 7:30 a.m. in rooms 12 and 14 of the convention center.

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### Cable fault locator incorporates waveform data storage



**Riser-Bond Instruments'** model 1220 time domain reflectometer, cable fault locator, locates and identifies cable faults and conditions in all types of metallic cable. Riser-Bond's Super-Store waveform data storage feature provides storage of the entire cable under test and all waveform information. A high-sensitivity and multiple pulse widths package, formerly an option, is now a standard feature on the model 1220. A built-in printer documents the waveform.

Circle (351) on Fast Fact Card

### Alpha entry software supports multiple environments

Pagemate II alpha entry software from **Miracom Technologies** sends messages to alpha pagers. The software is available in DOS, Windows and Novell LAN versions. Pagemate II supports access to multiple paging services with separate modem initialization for each. The software supports multiple languages, direct call, group calls and canned messages.

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## Readers' choice

Of all the new products and services in the June 1994 issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, here is your opportunity to acquire more information on them. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

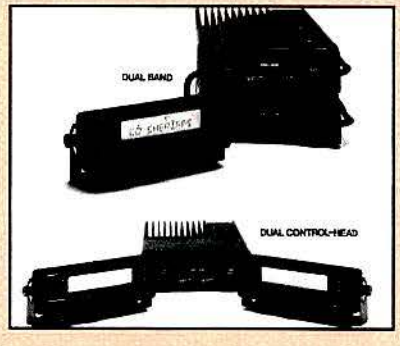
### Portable, mobile units use digital SMR services



**Motorola Land Mobile Products'** Lingo phone series includes the multi-service L3000 portable phone with flip and the LM2000 multi-service mobile phone. The units connect users to voice dispatch, wireless phone, Message Mail and data services that are available on the Motorola Integrated Radio System (MIRS). The L3000's features include an alphabetical directory, quick scroll and user programmability, all from the keypad. The LM2000's features include hands-free operation, speed dialing and illumination of the keypad, LCD and handset cradle for nighttime use.

Circle (500) on Fast Fact Card

### Mobile radios allow optional dualband operations




The TK-630, TK-730 and TK-830 "30 series" mobile radios feature dualband, dual control head options. The products feature PC programmability, rotary controls, front-mounted speakers and have backlit keys. The dualband option allows one control head to control two bands, thus allowing VHF and UHF transmissions from one radio. The dual control head option allows communication from two locations in a large vehicle. The radios, from **Kenwood Communications**, have full-featured control panels with a 12-digit, alphanumeric LCD and 32 channels divided into two groups.

Circle (501) on Fast Fact Card

### Specialized cables combine low loss, high shielding with high flexibility



LMR-240-UltraFlex and LMR-400-UltraFlex cables from **Times Microwave** are designed for applications requiring low-loss, highly shielded cables capable of repeated bending and installation in extremely tight spaces. The specialized cables feature stranded center conductors and thermoplastic rubber (TPR) jackets to promote greater flexibility. Both cable types have RF shielding exceeding 90dB. The LMR-240-UltraFlex has an attenuation of 10.0dB/100 feet at 900MHz and a minimum bend radius of ¾". The LMR-400-UltraFlex has an attenuation of 4.8dB/100 feet at 900MHz and a minimum bend radius of 1". Connectors designed for the standard LMR cables also fit the UltraFlex versions.

Circle (353) on Fast Fact Card

### Dc power supply accepts multiple switchmode rectifier modules

The TwinPack Plus dc power supply from **Power Conversion Products** consists of a 10½"H × 23"W mounting shelf that accepts as many as four modular, plug-in, switchmode rectifiers. Rectifier modules will produce ±24V/100A or −48V/50A dc outputs in an operating environment of −40°C to +65°C. They accept single phase ac input ranging from 176V to 264V, 45Hz to 65Hz, and offer precise dc voltage regulation, high efficiency and near-unity power factor. Shelves may be stacked in dc power systems to deliver load capacities as high as thousands of amperes. Parallel rectifier modules are interconnected through forced load-sharing circuitry.

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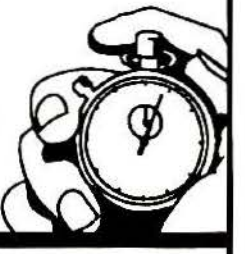
### Top-view 900MHz pager boasts clock, alarm, selectable alerts




The 900MHz LS 9300 pager is the premiere release in an LS series of pagers from **Uniden America**. The pager has a top-view LCD screen, time stamp, clock, and travel alarm. The pager also has multiple user-selectable alert modes and name tags. The unit has a 30-message queue, with 24 characters per message, and the ability to delete specific messages in the queue. Features that can be controlled by the carrier include out-of-range indicators, enable/disable message error display and custom-programmed wake-up screens.

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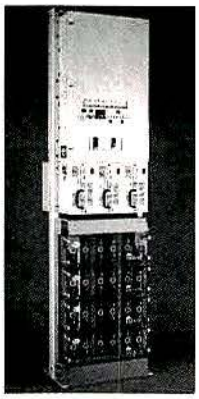
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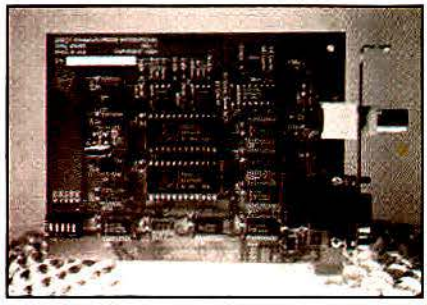
### Safety features mark rack-mount battery system for telecom relays



**Yuasa-Exide** has entered the telecommunications relay rack-mounted battery market with the introduction of a line of DDH modular, sealed valve regulated batteries. Ranging from 110Ah to 550Ah, the batteries come in four- and six-cell, freestanding, floor-mounted modules. All modules can be mounted between the rails of a 23" relay rack, and certain ratings can be installed between the rails of a 19" rack. Fire retardant jars and covers are standard, and clear plastic safety shields allow visual inspection of terminal posts without removing the shields. A slide fit assembly technique requires only two bolts for standard assembly, and a Dynaflow air management system assures air flow around each cell.

**Circle (356) on Fast Fact Card**

### Plug-in PC board generates tones, acts as two-tone paging encoder



The CommShop Tone Board for personal computers from **Direct Communications International** acts as either a subaudible tone generator for bench testing or as a two-tone paging encoder. Software-driven, the tone board performs signaling formats of two-tone sequential, DTMF, CTCSS, burst, and 5/7 tone and audio frequencies from 39Hz to 3,900Hz. Automatic drivers establish the proper tone frequencies, durations and gap timings based on the format and code. The software automatically activates microphone key and feeds the audio tones directly into a database that auto-enters pager tones and timing information. Paging calls are sent by selecting the user from a screen list. Audio output is available at the board's BNC connector or 9-pin D-sub paging interface connector. A software-driven digital output level control simplifies installation.

**Circle (357) on Fast Fact Card**

### Software provides administration, billing for repeater operations

Radiopac software from **John Mitchell** is a complete repeater management and billing system. It supports systems in LTR, Motorola, General Electric and conventional formats. Radiopac is compatible with all air time devices for conventional or trunked systems that are capable of providing a standard ASCII text file containing the necessary data to provide billing information. The software also provides a link to external accounting software, updating the customer database for both programs.

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## Cellular phone test set combines multiple functions and capabilities



**IFR Systems'** μCELL-100 test set for digital cellular phones includes several operating modes designed to increase security, throughput and productivity. Those modes include autotest; manual testing of the transmitter, receiver and antenna system; identification of MIN, ESN, SCM and type (TDMA, NAMPS, AMPS); setup for user-defined pass/fail criteria, call-processing parameters and printer output format; and viewing of test results. Features for verifying proper operation of a TDMA cellular phone include VSELP encode/decode; Π/4DQPSK constellation; authentication response verification, alert info; flash info; performance plots of transmitter power, receiver sensitivity, observed BER and VSWR; memory for storing setup configurations; and security protection for sensitive UUT and test set parameters.

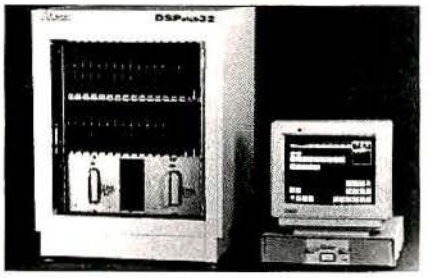
**Circle (359) on Fast Fact Card**

## Microwave radios' correction coding feature reduces transmission errors

The Quantum 13 and Quantum 15 digital microwave radios from **Digital Microwave** are available in channel capacities from 4xE1 to 1xE3. The radios are designed for point-to-point medium capacity applications for common carriers, corporate, government and cellular networks. All Quantum series radios have forward error correction coding to virtually eliminate transmission errors during normal propagation conditions and to extend receiver performance. An optional 11-Tap Transversal Adaptive Equalizer, coupled with a space diversity receiver configuration, provides high tolerance to dispersive fading. This allows longer path lengths in areas where rain fade events are not the limiting factor for availability. Both models are available in standard and high-transmit-power versions and include complete system diagnostics and maintenance features. The series is also available in 2GHz, 6GHz, 7/8GHz, 10GHz and 11GHz frequency bands.

**Circle (360) on Fast Fact Card**

## Console offers advanced features for smaller-scale dispatch applications



The DSPatch32 from **Avtec** is a small console solution designed to provide smaller dispatch operations with the features of a big system. The solid state design eliminates moving parts such as fans and disk drives. Even the level adjustment potentiometers have been replaced with solid state equivalents. The system uses independent distributed processing and redundancy to the individual card level. A single-point failure will not affect more than a single workstation or line. The system can be configured to support as many as 32 lines or operator workstations. External lines may be used for radio, telephone circuits (PSTN, PBX, CO or ringdown), intercom or other special use circuits. The operator workstation features a color touchscreen 14" SVGA display. Mouse or trackball operation is also available. Adding a keyboard converts a workstation into a maintenance console.

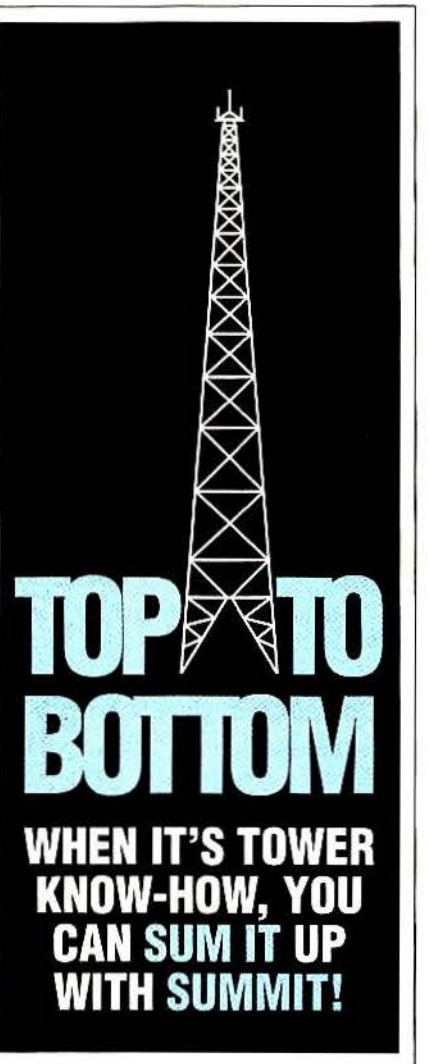
**Circle (361) on Fast Fact Card**

## Numeric business pager employs high-speed Flex coding system



**Motorola's** Pro Encore! numeric pager for mobile business use is coded for the Flex transmission system. The pager is designed to provide about 160 days of battery life using a AAA alkaline battery. The backlit LCD accommodates as many as 16 stored 20-digit numeric messages. Time and date are continuously displayed, and the clock function can be used to set a personal alarm.

**Circle (362) on Fast Fact Card**


**Circle (67) on Fast Fact Card**

### Dual-protocol trunking portables meet military environmental specs



**Standard Communications** has added an intrinsically safe rating to its 2W HX580T and HX581T trunked/conventional radios, now meeting military specifications for reliability in harsh environments. The dual-protocol portables fully compatible with either E.F. Johnson's LTR format, Motorola's Privacy Plus format, or conventional 800 MHz operation. The HX580T allows tracking of some or all of 10 systems, and as many as 109 groups. The HX581T provides tracking of 10 systems as well, one group per system. Both radios feature programmable scanning; DTMF, DCS and CTCSS selectable tones; time-out timer; busy-channel lockout; field programmability and non-volatile memory.

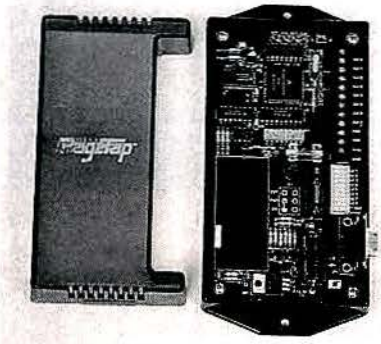
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### Consulting engineers provide coverage, design services at fixed fees

**Hartech** provides radio consulting engineering services, including topographical and coverage information for wireless and microwave radio users at a fixed fee. The firm offers expertise in communications needs assessments, radio system designs, path determination, and reliability and interference studies. Other services include specification and documentation generation, economic analyses and cost estimates, FCC application preparation, field engineering, and system acceptance and requirements assurance.

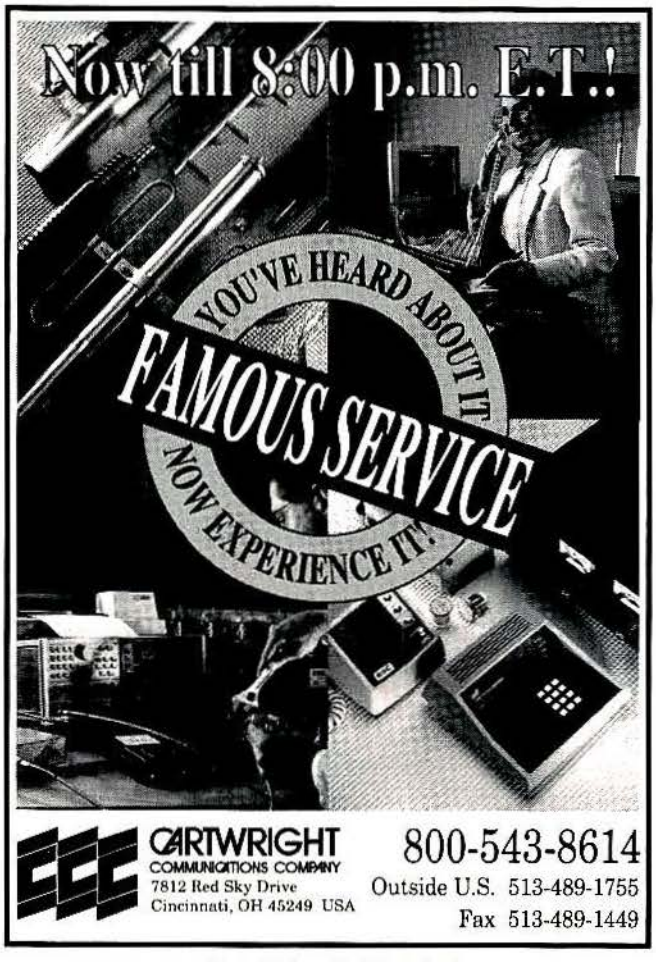
**Circle (364) on Fast Fact Card**

### Switch uses digital paging systems to transmit remote control signals



The PT8-OC remote control switch from **PageTap** uses existing digital radio paging systems to receive remote control signals. Signal audio is decoded by the unit and transferred to eight open collector outputs. Each output can be individually programmed to latch until signaled again, or set to time delay from 1/8 of a second to twenty-four hours, thereby combining latched outputs and time delays.

**Circle (365) on Fast Fact Card**

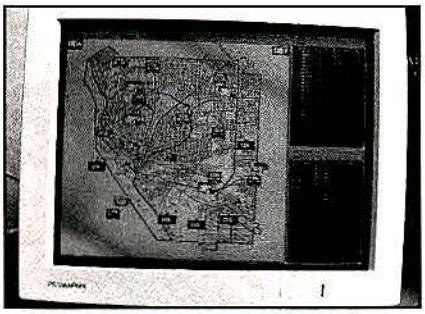




Circle (68) on Fast Fact Card




Circle (69) on Fast Fact Card

## Graphics-based fleet management system combines CAD and AVL



CadPak is a graphics-based computer-aided dispatching and automated vehicle location (CAD/AVL) system for fleet management. The system, from **Advanced Control Technology**, provides service order location and spotting and vehicle position tracking on a color map workstation display. Features include "point-and-click" dispatching of service work orders to selected fleet vehicles, two-way digital messaging, pen-based electronic work order form displays and records management. The system includes a dispatch workstation, cellular or RacoNet communications gateway, electronic color-map displays of the user's area, pen-based mobile data terminals with radio modem and internal GPS. Start-up assistance, documentation and user training is provided by the manufacturer.

**Circle (366) on Fast Fact Card**

## Paging software adds options to customer information, billing system

**Capital Data Systems'** Page-IT version 2.5 software supplements its existing Customer Information and Billing System. Page-IT's features include user-definable reporting, multi-site and central billing options, seamless integration with paging terminals and field-level validations on data entry. New modules in version 2.5 include retail activation, reseller access, point-of-sale processing, physical inventory reconciliation, service charge and upload access to the ROSS financial system. Other modules include a collections module, multiple bill formats and an interface for SkyTel billing data.

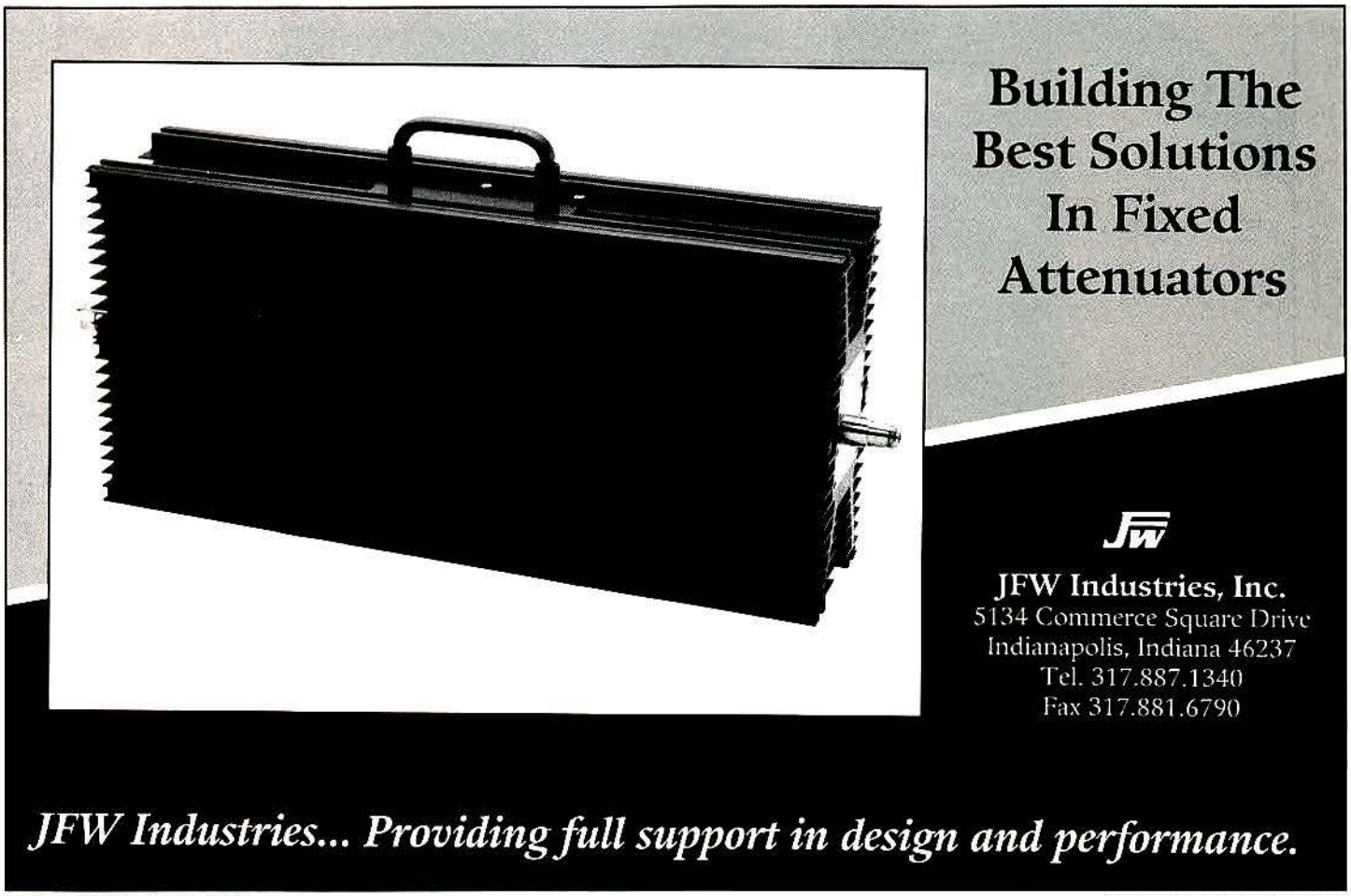
**Circle (367) on Fast Fact Card**

## Headsets accommodate a variety of work environments, headwear



**Peltor** offers lightweight noise-attenuating headsets and adapters for VHF and hardwired communication systems. These headsets are available with choice of boom or throat microphone. They are offered in a variety of styles, including overhead, back-band and hardhat attachment. A low-profile model is designed for use with full head protection gear. Adapters/push-to-talk switches are available for most VHF and UHF radios on the market.

**Circle (368) on Fast Fact Card**


Visit us at CTIA, Booth #2167.

Circle (70) on Fast Fact Card

### Helmet headset design anticipates abrupt or tactical motions by users



The TASC headset from **Television Equipment Associates** is for two-way radio applications where the user must perform aggressive or tactical movements without losing communications. A shallow 300Ω earphone is supplied in a thin nylon case with a rubber flange, allowing the user to monitor radio signals in moderate-to-high noise. The device is held in place with an elastic strap and a Velcro fabric fastener. Less than one inch thick, the entire assembly fits under most tactical helmets. The noise-canceling boom mic is positioned at the corner of the user's mouth with a flexible boom arm. The PTT switch D has a front surface button with a socket for an optional hand switch.

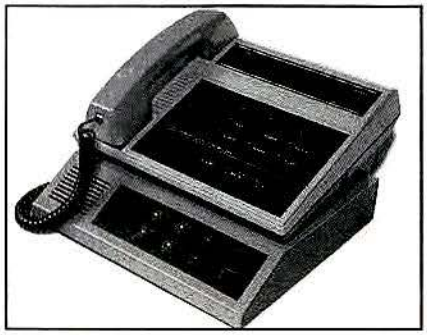
**Circle (369) on Fast Fact Card**

### Gateway uses 32-bit architecture for seamless paging expansion

The Micro 8 is a spin-off of **TeleLink's** DS5000 multipurpose digital communications switching platform and is designed to provide a cost-effective gateway for start-up paging operations. The product's feature sets and architecture are fully compatible with TeleLink's DS5000 16, 30 and 90 series of paging systems, offering seamless expansion capabilities to paging service providers using those systems. The Micro 8 incorporates the 32-bit processor architecture and version 1.5 software originally developed in connection with the DS5000 product family.

**Circle (370) on Fast Fact Card**

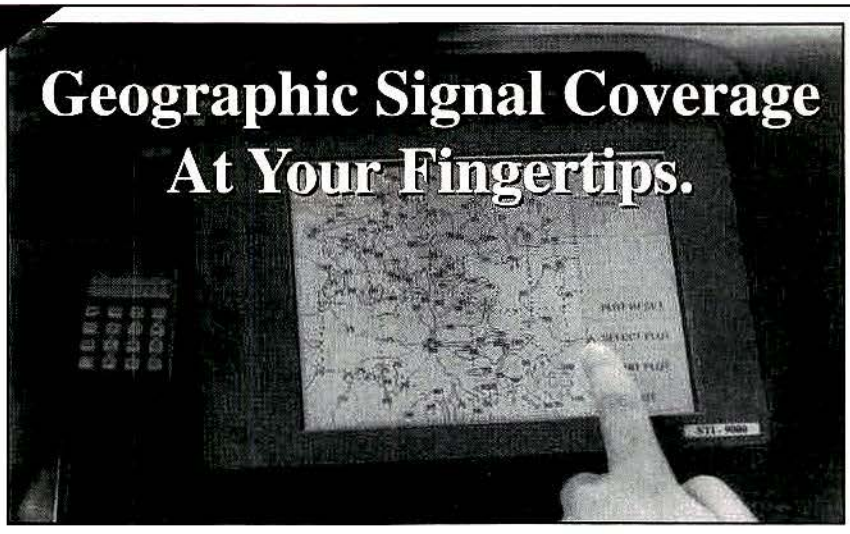
### Remote controller interface controls as many as 8 separate base stations



The model 20-88 multi-line remote controller interface from **IDA** allows a single desktop remote controller to control as many as eight separate base station radios. Designed to be used with any standard tone or dc remote, the 20-88 has its own speaker and volume control for "unselected" audio. Indicator lights identify which line is selected and which of the unselected lines has audio present. A timed mute function is dealer-selectable for each line. The compact design allows the unit to fit under a desktop remote.

**Circle (371) of Fast Fact Card**

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**Circle (71) on Fast Fact Card**

### Advanced features option expands single-line interconnect capabilities




An advanced feature set is available as an option for **Zetron's** model 30 WorldPatch single-line interconnect. The option equips the Zetron interconnect with mobile-originated hookflash, repeat courtesy tone, call-alert beeps, autodials and an output relay. Ten autodials can be programmed into the model 30 WorldPatch to allow single-digit dialing of preset telephone numbers. The output relay is an FET transistor output that may be remote-controlled with a DTMF code. The interconnect is remote-programmable by DTMF radio or Touch-Tone telephone. The unit supports both simplex and half-duplex operation. A repeat-control feature allows it to convert two mobile radios, or a separate transmitter and receiver, into a carrier-operated repeater. For advanced simplex operation, a number of programmable sampling and vox features are included, and an audio board is available as an option.

**Circle (372) on Fast Fact Card**

### Purchase order module completes equipment service information system

The release of the Purchase Order software module from **Serviceware** completes its Series 2 Service Information System. The system automates all aspects of equipment service relating to the work order. Previously released modules in the system include SP Manager, Logbook, Dispatch, Service Contracts, Inventory Control, and the Accounting Interface. The Purchase Order module helps manage spare parts and logistics by integrating with Logbook and Inventory Control to provide instant access to purchase orders, requisitions, and vendor information. The new module's returns subsystem tracks RMAs and dynamically updates physical inventory values.

**Circle (373) on Fast Fact Card**

### Two-way FM portable features PC programming and scanning



The 99-channel, VHF model 70-148 frequency-synthesized, two-way portable FM radio from **Midland International** is designed for land mobile service. The radio has a frequency range of 146MHz to 174MHz, selectable RF power outputs of 2W and 5W, push-button channel selection with LCD display and an internal preset squelch. Semi-duplex operation can be programed into 48 channels. The radio offers PC programming and cloning capability and provides scanning by a programmed scan list or triple watch. Other features include busy-channel lockout, rotary power/volume switches, and 83 DCS codes and 37 CTCSS tones randomly programmable by channel. The unit meets MIL 810 C/D/E shock and vibration standards.

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**Circle (72) on Fast Fact Card**

# *New products*

## Software option enables testing of digital trunked base stations



A licensed software option enables the Stabilock 4015 programmable radiocommunication set to test base stations using Ericsson's EDACS (Enhanced Digital Access Communications System) digital trunked radio system. The test set (formerly manufactured by Schlumberger Technologies) from **Wavetek** can monitor directly from the antenna, decode all telegrams and compute control-channel use. All data can be transmitted by modem and telephone lines to remote test stations. For tracking of sporadic errors, the test set is connected next to the base station. Data are then output to a printer, transferred on the RS-232 interface to a laptop, or transmitted by modem and telephone line to a central test station.

**Circle (375) on Fast Fact Card**

## Fixed replacement antenna design addresses call drop in fringe areas



**Centurion International's** replacement antenna for the DiamondTel 22X phone is a fixed antenna designed to improve phone performance and reduce call loss in fringe areas. The antenna is available in quarterwave (3½" and stubby) and halfwave (6") versions. The three models are CXS-M4M, CXC-M4M and CXH-M4M.

**Circle (377) on Fast Fact Card**

## Battery eliminators complement OEM battery replacement line

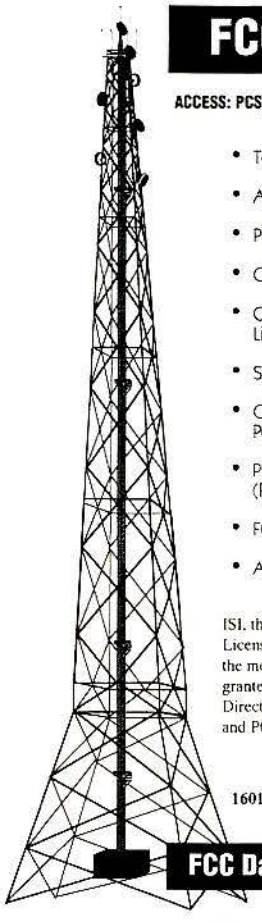
**W & W Associates** has added battery eliminators to its line of replacement batteries for transceivers. Eliminators are available for models from manufacturers including Alinco, E.F. Johnson, G.E., Icom, Kenwood, Kyodo West, Maxon, Midland, Motorola, Radio Shack, Standard and Yaesu.

**Circle (376) on Fast Fact Card**

## Station for 800MHz operations is available in three configurations

The 800MHz Viking VX Station is available in three configurations, each with variable (25W–75W) power: the AmeriCom Station, the Viking Community Repeater and the special application Viking Universal Station. All three synthesized stations from **E.F. Johnson** have status and alarm displays, programmable frequency and power output and diagnostic indicator/RF alarms. The AmeriCom, designed for AmeriCom network SMR operators, is available with optional telephone interconnect, including memory for 5,000 calls. The Viking Community Repeater includes a Call Guard/Digital Call Guard, DTMF programmable repeater panel, interface cable and two signaling choices.

**Circle (378) on Fast Fact Card**

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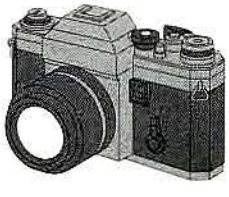
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## Do you have a photo you would like to see on the cover of *Mobile Radio Technology?*

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If you have a 35mm slide, transparency or other piece of art that you think would be worth consideration for our cover, please let us know. We would love to hear from you!

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# Literature

## Computer pricebook includes full-length descriptions

This program from **Cartwright Communications** carries full-length descriptions and quantity pricing. Customers can look up products by the part number, check the list and dealer prices and view quantity discount pricing. To place an order, tag all desired products, and the program automatically generates the purchase order. It includes purchase order number, billing and shipping addresses and any special instructions. The program runs on an IBM PC or a clone and is available on 3½ and 5¼ double-sided double density diskettes.

**Circle (300) on Fast Fact Card**

## Planning guide details coaxial cable, connectors

A 40-page planning guide for ½-inch and smaller Heliax coaxial cable, connectors and jumper cable assemblies is available from **Andrew.** The guide provides a detailed comparison between Heliax coaxial cable and braided cable. Illustrated with color photos and charts, the easy-to-read catalog contains information on the newest Heliax cables and accessories, including Valuflex jumper cable assemblies, $^{7}/_{16}$ DIN connectors, Cold Shrink weatherproofing kits and color-matched cable jacketing options.

**Circle (301) on Fast Fact Card**

## Reference guide features base station antennas

A 241-page catalog covers base station antennas and antenna systems from the **Decibel Products** division of Allen Telecom Group. The catalog was redesigned to simplify the ordering process. The table of contents, product number index and color coding allow users to identify and locate products quickly and easily. Listings include radio frequency management components and site monitoring products; cellular and paging systems measurement and testing equipment from Grayson Electronics division; and the Antenna Specialists product line, which is now manufactured at Decibel.

**Circle (302) on Fast Fact Card**

## Application note describes panel antennas

A six-page application note describes characteristics of various directional antennas typically used in land mobile and other point-to-point systems and mentions the pros and cons associated with their use. The brochure from **Richard Hirschmann of America** details the use of the company's panel antennas and offers advice on why and when a panel antenna can be worthwhile.

**Circle (303) on Fast Fact Card**

## Book explains schematic diagrams

*Schematic Diagrams: The Basics of Interpretation and Use* is designed to teach readers about schematic diagrams in a simple, systematic manner. The book from **Prompt Publications** shows the reader how to recognize schematic symbols and determine their uses and functions in diagrams. Subjects covered in the book include component symbols and diagram functions, power supplies, audio system diagrams and computer diagrams.

**Circle (304) on Fast Fact Card**

## Brochure identifies optimum system configurations

A technical brochure identifies measurement accuracy sources and optimum network analyzer configuration for complete test systems covering RF, microwave and millimeter wave applications. The brochure from **Wiltron,** a member of the Anritsu Wiltron Measurement Group, specifically identifies 54100A series models, measurement components and system accessories for optimum configuration covering specific manufacturing and field service applications.

**Circle (305) on Fast Fact Card**

## Book describes digital audio

*An Introduction to Digital Audio,* by John Watkinson, describes the principles of digital audio in an easy-to-read format with many explanatory line drawings. Topics covered in the book from **Focal Press** include introducing digital audio, conversion, digital coding, digital audio interfaces, magnetic disk drives, digital audio editing and optical discs in audio.

**Circle (306) on Fast Fact Card**

## Catalog features test equipment

A 48-page supplement catalog from **Contact East** covers new test instruments and tools for network specialists, administrators, MIS managers, LAN managers, telecom specialists, engineers and cable installers. Products for installing, testing and maintaining networks are included from several manufacturers.

**Circle (307) on Fast Fact Card**


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For interconnect and remote control applications

MODEL NC401



The Model NC401 is a micro-miniature DTMF decoder, designed for selective control of local or remote applications. Measuring .80"W x 1.37"L x .23"H, the NC401 combines three distinct, multi-addressable decoders offering multiple user-configurable functions. All programmed features are stored in non-volatile E2Prom memory and are easily programmed by means of a conventional DTMF encoder or the Model NC500 Universal/P.C. programmer. This highly engineered decoder is ideal for portable radio applications having limited space for accessories. The NC401 comes complete with micro-miniature 14 pin header and 12" color coded cable assembly. For FREE detailed information ask for the NC401 user's manual.

MODEL NC409



The Model NC409 is a DTMF ANI/Alarm status encoder and companion product to the Model NC401 DTMF Decoder designed to automatically or manually generate any of the 16 DTMF characters. The NC409 features 15 memory locations of up to 30 digits each plus last number redial and multiple user-configurable functions. Programming is easily performed by means of a 12 or 16 button "X-Y" keypad with common ground or the Model NC500 Universal/P.C. programmer. The NC409 measures .85"W x 1.36"L x .165"H and comes complete with micro-miniature 14 pin header and 12" color coded cable assembly. For FREE detailed information ask for the NC409 user's manual.

**For detailed information or product catalog call 1-800-874-8663 or Fax 916-477-8403**

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# People


Hardison


Taylor


Loglisci

**Lowell Hardison,** area vice president of sales, western region, for Glenayre Technologies, Charlotte, NC, advances to vice president of sales, narrowband personal communications services.

Changes at Allen Telecom Group (ATG), Cleveland:

**Lawrence L. Taylor** leaves Motorola Cellular Infrastructure Group at its Laguna Niguel, CA, location to join ATG as western region major account manager based in Laguna Niguel.

**Nicholas R. Loglisci Jr.** leaves Motorola in its Glen Rock, NJ, location as an account manager to join ATG in the northeastern regional office as a major account manager.

**Mark S. Allen,** director of engineering and technology for E.F. Johnson, Burnsville, MN, advances to vice president of engineering.

**Spence Angel** departs Cantus, Bloomington, MN, as president to join CML Technologies, Atlanta, as director of strategic marketing.

**George Badger,** vice president and director of marketing for Svetlana Electron Devices, Portola Valley, CA, advances to president. Svetlana Electron Devices is the American corporation for worldwide marketing, sales and support of the power grid tubes of Svetlana, St. Petersburg, Russia.

Changes at Cobra Electronics, Chicago:

**Norm Goldberg,** marketing manager for Cobra Electronics, moves up to national marketing communications manager.

**Charles A. Stott** departs Dynatech, Burlington, NH, as division executive to become vice president of operations for Cobra.

Changes at Qualcomm, San Diego:

**Anil T. Kripalani** leaves AT&T Bell Laboratories as head of the Wireless Systems and Services Architecture and the Integrated Access Architecture departments to join Qualcomm as vice president of business development for the company's wireless telecommunications division.

**Ronald E. Foerster** departs US West New Vector Group, Bellevue, WA, as executive director and chief technical officer to join Qualcomm as senior vice president of wireless infrastructure products for the company's wireless telecommunications division.

This item corrects an announcement printed in the January 1995 edition:

**George Hebner** adds to his responsibilities as president of All American North, Southport, CT, by accepting an assignment as an independent land mobile products representative for the eastern United States territory on behalf of Telex Communications, Minneapolis.

# Letters from readers

**Communications privacy**

Thank you for your position on the Electronic Communications Privacy Act of 1986 as indicated in the September 1994 "Editorial."

As a radio hobbyist and a columnist for a monthly radio publication, I could not agree more. The burden of privacy should be borne by the user without placing unenforceable and ridiculous restraints on those who manufacture receiving equipment and those who listen as a hobby or pastime. In public safety, those who wish for privacy add that capability to their communications systems, and today's level of scrambling is virtually unbreakable.

There are aspects of public safety and federal protection that require such privacy, and the needs are being met. The cellular industry should advance to a similar level of technology to guarantee that conversations cannot be intercepted—not by regulation of receivers and users, but by new technology.

Unfortunately, some vendors seem to think that all radio hobbyists are thieves and murderers, and the vendors sell the "privacy" issue using such references. Only a minority uses scanners for illegal purposes, and these individuals should be prosecuted if a monitor receiver is used in the commission of a crime. Most of us scanner users are law-abiding citizens, including many employees at public safety agencies. If cellular listening is "illegal," what's next?

It's just like the firearms issue: When scanners are outlawed, only outlaws will have scanners. Thanks for your support.

Michael G. Redman
Clayton, MO

**Transmitter combining**

I found the October 1994 issue of particular interest, especially the article "Taking the Mystery Out of Combining."

Phil Jachowski of Diablo Communications did an excellent job of explaining the need to manage the complete site, a position that my own organization, Motorola, has believed in for years! In fact, Motorola believes in it so much that we installed our own 800MHz and 900MHz specialized mobile radio (SMR) systems on the site discussed in the article. In fact, the very combiners shown in the photos on pages 11 and 16 are Motorola's combiners, not Diablo Communications' system at all!

The system uses three broadband antennas, one to run the 806MHz and 896MHz receive systems and two transmit antennas that can handle 20 channels of 800MHz and 10 channels of 900MHz SMR transmitters.

Thanks, Phil, for the nice photos, and I hope the installation meets with your approval.

Paul T. Mason
Antenna Site Engineer
Motorola Network Services Division
Richmond, CA

*Mr. Jachowski's reply:*

Paul Mason is correct that the combining systems pictured in my article are owned and maintained by Motorola. Because of the large number of systems that Motorola operates at Diablo Communications sites, quite often they do use their own combining systems, as well as Diablo combining systems, or both.

I assure Paul that I know whose combining systems are whose and certainly do not want to deprive him of the recognition due for a nice system at Mt. Tam.

Phil Jachowski
Director of Operations
Diablo Communications
Richmond, CA





Circle (77) on Fast Fact Card




Circle (78) on Fast Fact Card

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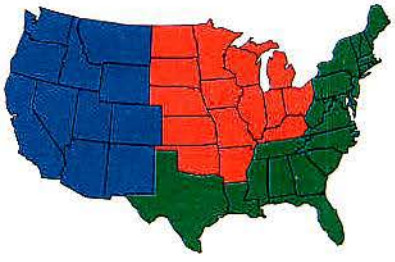
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# Classified

## Professional Consulting Services


Classified Ad Index

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The Milwaukee Police Department seeks an individual to install and maintain all radio communication equipment used by Police and other City departments. Position requires 3 years of experience in installing and servicing fixed site and mobile radio communication equipment, including base stations, voting receiver systems, microwave radio equipment, radio paging systems and antenna management systems. Other requirements include a high school diploma, valid driver's license, and possession of a General Radio Telephone Operator's License or equivalent industry certification, and an Amateur General Class License. Salary range is $31,238 to $39,571 with excellent benefits. Experienced applicants may start above minimum. Call or write for application materials before February 17:

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*An EEO employer.*

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Must be certified.
Full time position available.
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*Flat rate does not include parts

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MOSS COMMUNICATIONS

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A & C
STYLE
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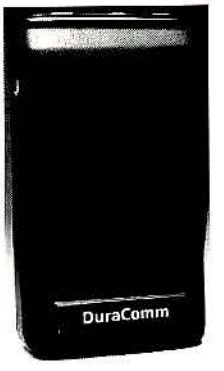


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MULTI-FORMAT ENCODER
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## Paging

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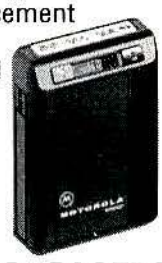
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Brand new.....$325. ea.

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vent fan.....$3200.

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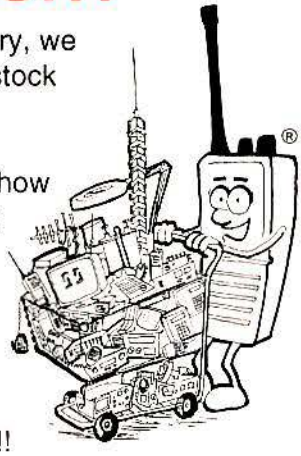
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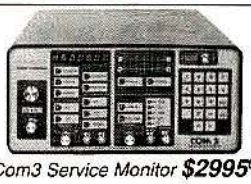
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**CALL US FOR THE SOLUTIONS TO YOUR TESTING NEEDS!**

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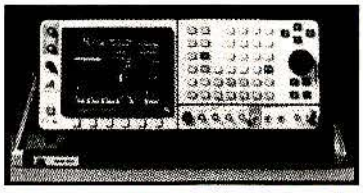
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**MOTOROLA CLEAN TRUNKED TYPE RADIOS**

**PORTABLES**

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|---|---|
| VISAR W/CHARGER HC BATTERY USED | $995 |
| MTX900 6 SYS CHARGER NEW BATT. | $745 |
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| MTX810 2 SYS CHARGER/NEW BATT. USED | $695 |
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| PP1000X 800 W/ACCESSORIES | $795 |
| SYNTOR X2 W/ACCESSORIES | $195 |
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| PP750X | $595 |

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| Motorola R-2008/D/HS with Cellular Test | $6500.00 |
| Motorola R-2008-C with Cellular Test | $5500.00 |
| Cushman CE-50/A1/TG Spectrum/Tracking/Battery | $4200.00 |
| IFR 1000-A with Battery | $2700.00 |
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## AB$OLUTE LOWE$T RADIU$ PRICE$!

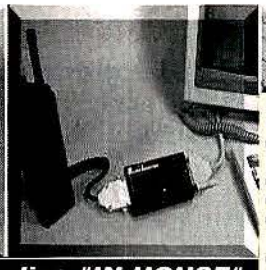
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**Info 310-268-2464**
**Fax 310-268-2474**

MOTOROLA **Radius**® FM 2-WAY RADIOS

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*Prices Subject to Change Without Notice.*

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- Uses Surface Mount Technology (SMT).
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- Includes AC Adaptor, XT/AT cable, Serial cable, 1 Year Warranty.

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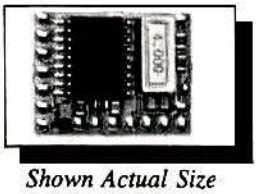
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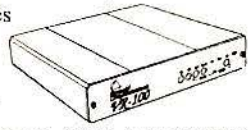




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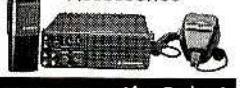
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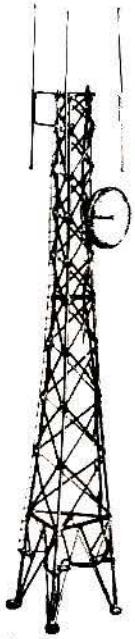
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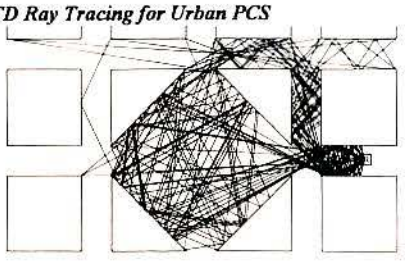
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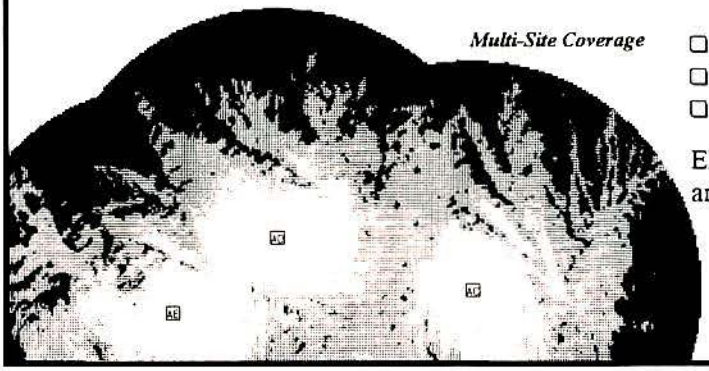
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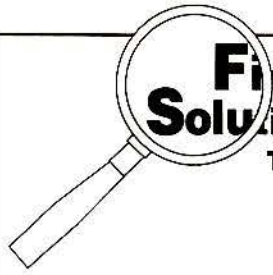
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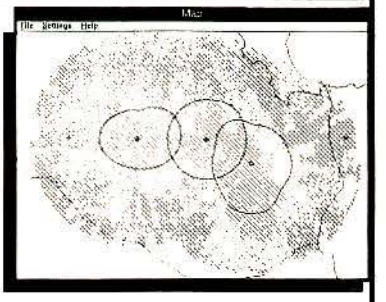
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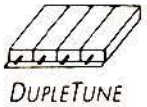


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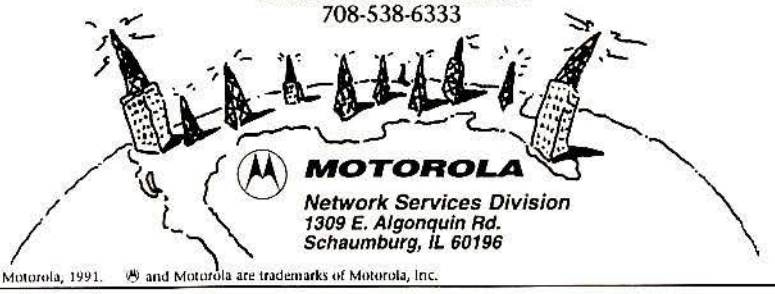
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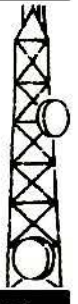
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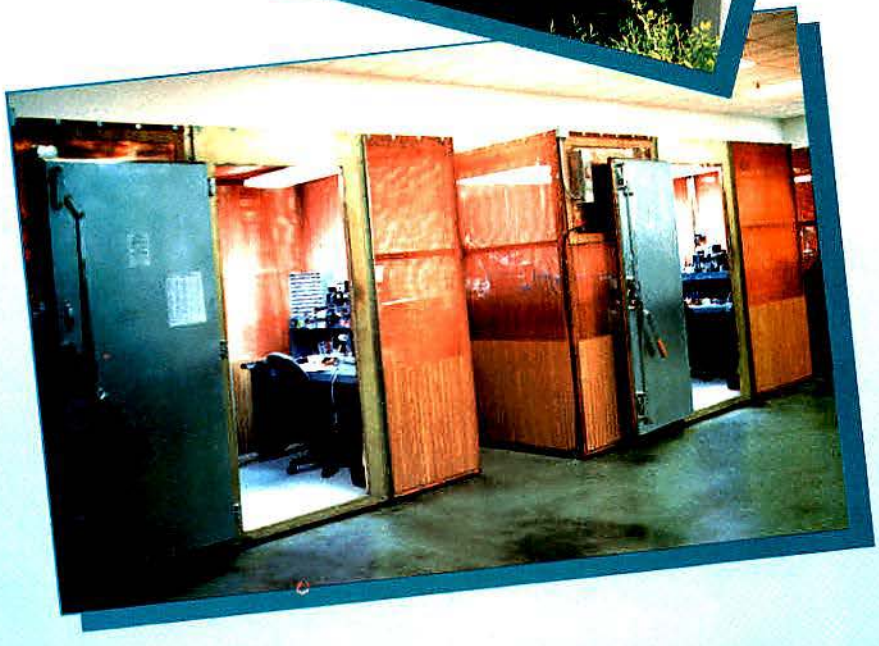

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| Bramco, Inc. | 90 | 113 | 513-773-6255 |
| Cartwright Communications | 72 | 68 | 800-543-8614 |
| CELWAVE | 18-19 | 15 | 800-321-4700 |
| Centurion International Inc. | 9 | 7 | 800-228-4563 |
| Chargeguard Corp. | 90 | 112 | 800-458-3410 |
| Cimarron Technologies | 25 | 22 | 800-487-7184 |
| Communications Associates, Inc. | 85 | 99 | 800-435-9313 |
| Communications Data Services | 93 | 117 | 800-441-0034 |
| Communication Instruments | 93 | | 303-962-9998 |
| Communications Specialists | BC | 3 | 800-854-0547 |
| Computer Resources Inc. | 92 | 116 | 205-987-1523 |
| Connect Systems, Inc. | 15 | 12 | 800-545-1349 |
| Control Signal Corp. | 12 | 8 | 303-989-8000 |
| CPI Communications, Inc. | 65 | 58 | 214-437-5320 |
| Crystronics, Inc. | 82 | 92 | 305-566-6949 |
| Cushcraft/Signals Corp. | 21 | 17 | 800-258-3860 |
| Dapa Communications | 51 | 45 | 716-373-7228 |
| Datacom Inc. | 28 | 24 | 217-222-0160 |
| Diablo Communications, Inc. | 95 | 123 | 510-236-3700 |
| D & L Communications, Inc. | 59 | 52 | 800-336-6825 |
| Doppler Systems, Inc. | 79 | 78 | 602-488-9755 |
| Douglas Integrated Software | 69 | 63 | 904-656-8673 |
| Duracom | 83 | 94 | 913-746-8300 |
| EDX Engineering | 92 | 115 | 503-345-0019 |
| El Paso Communications | 84 | 95 | 915-533-5119 |
| EMR Corp. | 50 | 44 | 602-581-2875 |
| E Trunk Systems, Inc. | 86 | 103 | 914-245-1128 |
| Fourth Dimension | 83 | 93 | 516-467-1220 |
| Frequency Management | 87 | 106 | 800-800-9825 |
| Gamber Johnson | 54 | 47 | 715-344-3482 |
| Grayson Electronics | 17 | 14 | 800-800-7465 |
| Haewa Corporation | 69 | 64 | 800-783-4239 |
| Harger Lightning Protection | 20 | 16 | 708-362-4848 |
| Henry Radio | 65 | 59 | 800-877-7979 |
| Hewlett Packard | 53 | 46 | 509-921-4001 |
| Hustler, Inc. | 29 | 26 | 800-949-9490 |
| Hutton Communications | 14 | 11 | 800-442-3811 |
| Hy-Q International | 85 | 98 | 606-283-5000 |
| IFR Systems, Inc. | 43 | 37 | 316-522-4981 |
| Interactive Systems Inc. | 76 | 75 | 703-812-8270 |
| JFW Industries, Inc. | 73 | 70 | 317-887-1340 |
| KNS Electronics Inc. | 94 | 119 | 408-432-8100 |
| Larsen Electronics | 37 | 32 | 800-426-1656 |
| Lazer Beepers, Inc. | 94 | 120 | 800-354-3405 |
| Leathersmith | 12 | 9 | 800-233-0440 |
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| McManus Communications | 81 | | 501-763-6250 |
| Mechem Electronics | 87 | 104 | 703-891-0569 |
| Meridian Communications | 41 | 36 | 818-222-5655 |
| Microwave Filter Company Inc. | 36 | 31 | 315-437-3953 |
| Midian Electronics, Inc. | 27 | 23 | 602-884-7981 |
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| Modular Communication Systems | 46 | 40 | 818-764-1333 |
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| MX-COM, Inc. | 7 | 6 | 800-638-5577 |
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| Pirod, Inc. | 72 | 69 | 219-936-4221 |
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| Polyphaser Corporation | 55 | 48 | 800-325-7170 |
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| Quantum Publishing Inc. | 94 | 121 | 415-381-4488 |
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| RAM Communications Consult. | 81 | 90 | 908-636-6970 |
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| Sinclair | BELLYBAND | | 905-727-0165 |
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| SMC Electro-Mount | 40 | 34 | 800-527-1079 |
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| Valmont Industries, Inc. | 48 | 42 | 402-359-2201 |
| Vega, A Mark IV Company | 1 | 4 | 818-442-0782 |
| Versatel Communications | 87 | 105 | 800-456-5548 |
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| Wetec Electronics | 68 | 107 | 901-286-6275 |
| W & W Associates | 63 | 56 | 800-221-0732 |
| WirelessWorld Expo '95 | 57 | 50 | 800-458-0479 |
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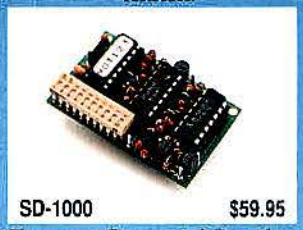
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